British and Metric Measures.

At the eighth Ordinary Meeting of the Session of the Institution of Civil Engineers, held on the 20th of January, Sir Frederick J. Bramwell, F. R. S., President, in the chair, a paper was read on "A Comparison of British and Metric Measures for Engineering Purposes," by Mr. A. Hamilton-Smyth, B. A.

The paper was limited to comparing the advantages for engineering purposes of measures of length, surface, capacity, weight, and pecuniary value, as used in England, with decimal systems of the same classes of measures. As the arithmetical notation of all civilized nations was decimal, all decimal systems had the advantage over others of dispensing with the compound rules of arithmetic and of facilitating the use of logarithms. The metric system had the further advantage over other decimal systems of being used by 240,000,000 people, with whom 60 per cent. of the foreign trades of England was carried on, and of all its terms being correlated, and derived from one convenient, well-known standard of length. Some British measures had the advantage over all decimal measures of being capable of finite ternary sub-division. On account of the pre-eminent position held at present by England and the United States in the manufacture of engineering machinery and material constructed to exact British sizes, a considerable practical advantage was derived from the use of British measures in engineering works. A large amount of capital was invested in machinery constructed to manufacture British articles of exact sizes, and the engineering literature expressed in terms of this measurement was extensive and valuable. English and American engineers carried in their memories, ready for application, a great number of leading or standard, dimensions, so that the substitution of other measures in their general practice would be inconvenient; and these measures had the further advantage of being already familiar to the working classes in England and America. Although the depreciation in value of certain machinery, due to a general change in measurements, would be very serious, still the existing machines would, in any case, last but comparatively few years, or become superseded by others of improved construction. The gist of English engineering literature would soon be translated into other terms of measurement, if the necessity arose. Both the metre and the yard had the advantage of being the approximate length of a human stride, and the former was about the limit to which a human being could conveniently place his hand apart when measuring with accuracy along a vertical surface. The British foot was merely a ternary subdivision of the standard yard, and in practice was often not used as a linear unit. Carpenters, for instance, measured a plank by the number of two-foot rule lengths it included, and had then to complete the total length by doubling the number of units they had made use of. A plank could be measured with a metre in about one-third of the time occupied in measuring it with a one-foot rule. The British inch was much too large to serve as the lowest integral unit in a scale of linear measurement, and even one-sixteenth of an inch was too large for minute work. The millimetre was, on the other hand, a convenient unit for ordinary minute work, and its decimal sub-divisions were as suitable for microscopic work as thousandths of an inch. The English practice of taking levels for building work in feet and their decimal sub-divisions, and of translating the resulting dimensions into feet, inches, and fractions of inches for the workmen, was most troublesome and productive of error,

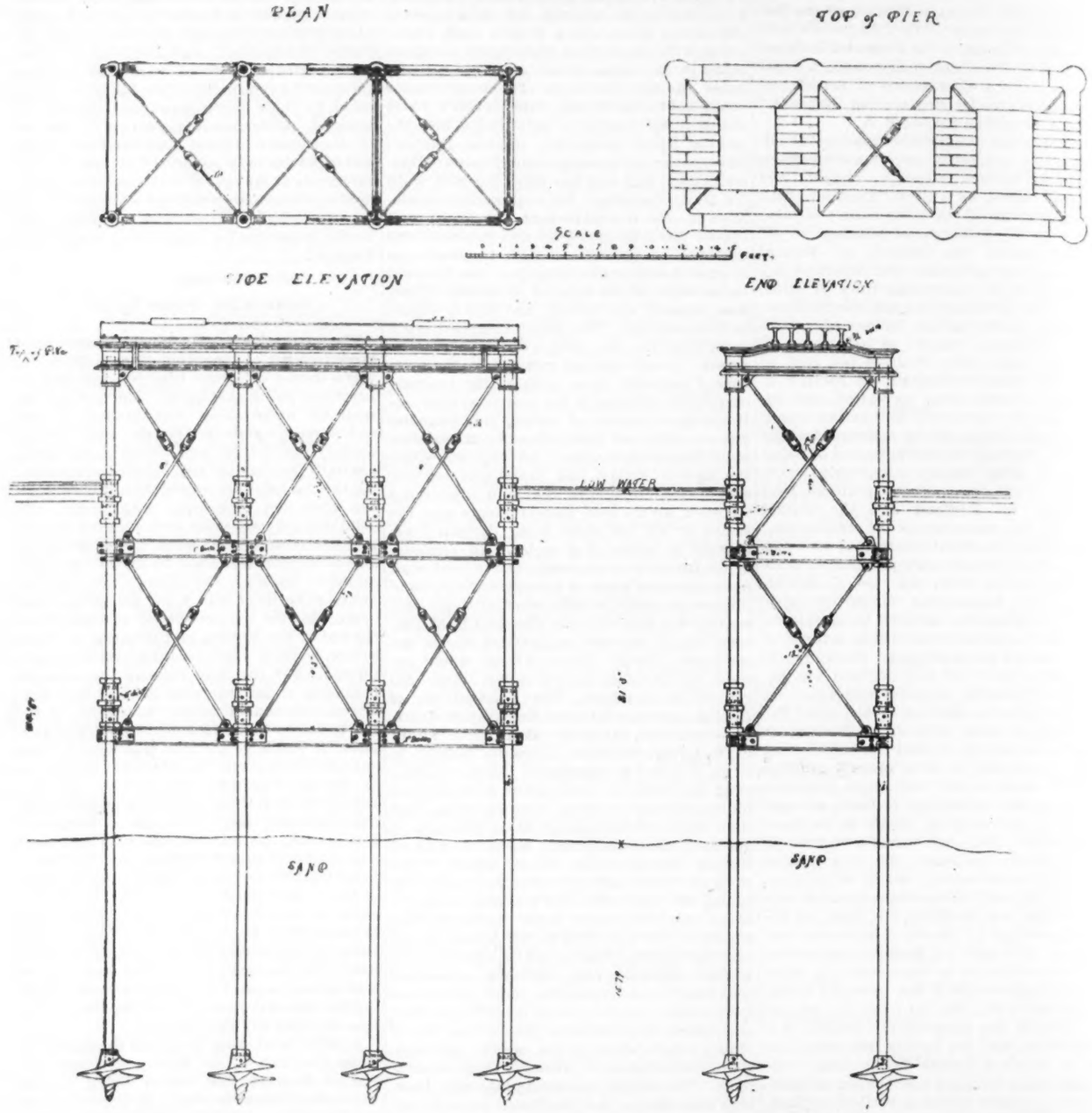
For all ordinary levelling the division of the metric levelling-staff into centimetres was sufficently minute, as the centimetre divisions could easily be subdivided, at least binarily, by ocular estimation, and metric levelling was practically more accurate for building work than levels taken with a British staff, on account of the dimensions given to the workman being in the same terms as those actually noted through the level. The twenty-meter chain had the advantage over Gunter's chain in that it was capable of subdivision into the smaller linear measures, whereas Gunter's link was the lowest integral subdivision of Gunter's chain, and was too large for any work but land measuring. For engineering calculations it was desirable that the linear unit should have its multiples and sub-multiples arranged in accordance with the universal system of arithmetical notation; that it should be the basis of the units of measures of surface, capacity and weight; and that it should be international. The meter complied much more fully than the yard with these requirements. In calculations relating to the pressure of materials upon surfaces, the intimate correlation existing in the metric system between the measures of weight and capacity was valuable, and hydraulic calculations were much simplified thereby. An engineer using the metric system had practically but one unit of measurement to deal with throughout his work, all his field measurements and the scales of all his plans being decimally expressed in terms of a meter. An engineer using British measurement had to deal with many different kinds of measures having complicated relations to each other, and also with a number of gauges, trade-sizes and local customs, which rendered comparison of cost exceedingly difficult. Many of these would become obsolete if the metric system came into general employment. The habitual use of British measures debarred English and American engineers, to a great extent, from profiting by foreign technical literature written in terms of metric measurement. The advantages of an international language of measurement for engineering purposes were so great, that they would counterbalance the advantages of any new decimal system, based on unit of British measurement. In so much of the work of a civil engineer's office as consisted in taking out quantities and making estimates, about one-third more work could be done within a given time with metric measures and decimal currency than could be effected with British measures and currency. Assuming that binary sub-division was more convenient for common purposes than decimal sub-division, there was nothing to prevent the use of binary sub-divisions of the metric measures, as they all admited of precise decimal equivalents. The metric scales for plans and drawings were simple, and facilitated mental comparison between the dimensions on paper and the distances in nature they represented. As regarded the saleability of articles manufactured in series of sizes, there was no reason to suppose that purchasers would continue to prefer series of sizes advancing by the exact metrical equivalents of the sixteenths of a British inch, if the fractional divisions of an inch were no longer in ordinary use as linear measures. The maximum advantage from the use of metric measures could not be obtained unless they were used in conjunction with a system of decimal currency. The reasons given by the late Sir John Herschel and by Sir George Airy, Hon. Members Inst. C. E., for preferring the decimal sub-division of the pound sterling to any other decimal arrangement of British currency, appeared unanswerable. By depreciating the nominal value of the existing bronze tokens by 4 per cent., the British currency would be completely decimalised without the introduction of new coins. For purposes of account, the penny would be 0.0004 of a pound sterling, or four mils, but the name of penny can be retained. The alteration of national measures of pecuniary value could only be effected by compulsory legislation, whereas the general adoption of the metric system, being already legal, though not compulsory, might be brought about gradually through the example and influence of engineers. Judging from continental experience, it would seem that the best prospect for reform lay in the initiative being taken by those professions most directly interested. If the standing orders of the Houses of Parliament allowed Parliamentary plans and estimates to be submitted in metric measurements at the option of the engineer, practical opportunities would be afforded of testing the relative advantages of metric and British measures for engineering purposes in England.

Opening the Mersey Tunnel.

The inspection of the Mersey Tunnel by a large number of shareholders and Directors was a matter of great interest yesterday at Liverpool and Birkenhead. The first act for such an undertaking was obtained in 1860 and several additional powers were subsequently applied for and obtained, but it was not until 1880 that the real operations for making the tunnel were undertaken. Since then the work had progressed with energy, the solid new red sandstone rock forming an admirable material to work upon. Perfectly able to support itself, and to endure the operations of blasting, the tunnel has only required to be lined with brick for the purpose of stopping out the percolation of water from the bed of the Mersey, at a distance of about 30 feet, beneath which the tunnel has been perforated. For the like reasons the physical character of the stone has enabled the portions of the tunnel under the streets of the two towns to be carried on without the purchase of buildings and land which would have been needful to cover the effects of subsidences in the case of ordinary excavations. The tunnel is now entirely bricked and completed from one side of the river to the other, a distance of 1,250 yards. Its form is that of a depressed oval, and it is 26 feet in width and 21 feet in height, the invert being nearly equal in form to the arched portion overhead. The brickwork of blue Staffordshire bricks is 3 feet in thickness at the invert. Below the tunnel there is a drainage heading running continuously with the tunnel itself 7 feet in diameter; into this at frequent intervals the water entering the tunnel is pumped, and the tunnel is in this way kept dry and efficient.

A party numbering about 200 descended in cages the shaft of the Liverpool works and walked forward, the tunnel being lighted throughout its entire length by powerful electric lights; another party entered the tunnel at the Birkenhead end, and these two parties met in the middle of the tunnel where a platform was erected on the line dividing Cheshire and Lancashire. Here addresses were made; the Mayors of Liverpool and Birkenhead shook hands and proclaimed the barrier between the two counties abolished. The parties then pursued their courses, the one going on to Birkenhead, the other to Liverpool. On the Liverpool side there is a large subterranean station, with platforms and provision for lifts which will be capable of elevating 240 passengers to the level of James Street in 40 seconds. This station is 400 feet long, 50 feet in width, and 38 in height. The further extremity as yet attained on the Liverpool side is under the center of Church Street, close to the Cathedral. When the traffic is worked the tunnel will be ventilated by two fans, one 40 feet and one 30 feet in diameter. Alongside the tunnel there is a ventilation heading cut in the rock 1,000 yards long and 7 feet 4 inches in diameter. On the Birkenhead side there will be a similar station under Hamilton Street and thence the tunnel continues under the London and Northwestern Railway and Great Western Railway to the Haymarket. Both ends of the tunnel railway will ultimately be brought to the surface, and connected with the main lines proceeding from Liverpool in all directions.—*From the London Standard, Jan.* 14.

MOBILE RIVER BRIDGE; PLAN AND ELEVATION OF PIER.



The Mobile River Crossing of the M. & M. R. R.

Written for ENGINEERING NEWS

BY COL. WM. M. PATTON, C. E.

Prior to the year 1865, the immense swamps, forming so large a part of the Gulf States and surrounding many of the largest and most important of the cities of that section, seemed to present an almost impassable obstacle to railroads pointing south and west, projected or constructed. The Mobile & Ohio R. R. had its southern terminus at Mobile, and the Mobile & Montgomery R. R. had its southern end at a point on the Tensas River, some 21 miles from Mobile. The freight and passengers of the latter line were transferred to Mobile by a regular steamboat line owned and operated by the R. R. Company. The business of both roads with New Orleans, and other Gulf cities of Louisiana and Texas, was carried on by the regular steamship lines plying between the points named.

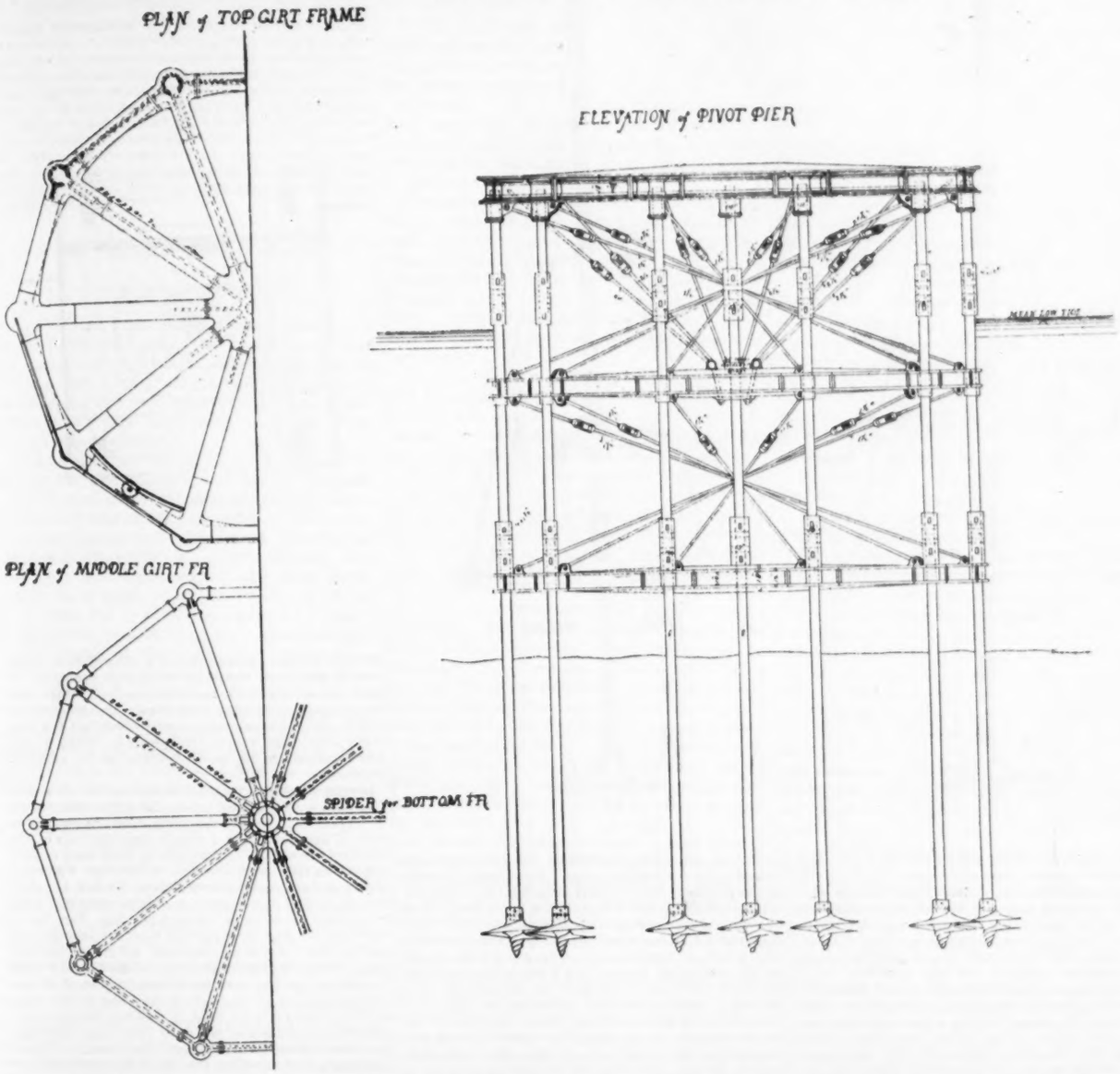
The great Northern & Southern R. R., starting at Chattanooga and ending at Meridian, Miss., where it connected with the M. & O. R. R., was then partly constructed, the Chief Engineer being the gallant Gen. R. E. Rhodes. This line was completed, after the war, under the name of the Alabama & Chattanooga R. R., and it now forms a link in the Cincinnati Southern railway system. The author was in charge of the construction of the Warrior River Bridge, its trestle and pile approaches and some 18 miles of the grading.

The then condition of affairs is now entirely changed. The M. & M. R. R. has been extended across the swamps and rivers to Mobile; the N. O., Mobile & Texas R. R. has been built, and the Cincinnati Southern, ignoring its connection with the M. & O. R. R. at Meridian, has constructed an independent line from that point to New Orleans. To a person thoroughly acquainted with the Southern swamps, it is not surprising that engineers hesitated and capitalists figured, before undertaking the construction of a railroad through them. In these swamps, cane brakes alternated with forests, and both were apparently floating upon an interlaced mass of roots as their only means of support. The matted roots of the cane form a crust strong enough to carry a track and its engine and dump cars; but, when two or three feet of earth is piled upon it, the combined weight breaks through this mat and the soft, silty material beneath sinks, and the swamps on each side of the embankment bulge up. This continues until it seems a useless task to pile on any more earth, but a little persistance will be rewarded by the discovery that this soft material can be consolidated sufficiently to support, with a wide base, the proposed embankment. It is gratifying to find, at last, that the bank made the day before had not disappeared by the morning after; but the borrow-pit in the sand hills is the only evidence of the quantity of material required to make an embankment apparently only a few feet high.

Pile trestles are generally constructed by driving four piles to a bent, the bents being 12½ feet apart. Some engineers, however, prefer to use three piles to a bent, considering a trestle so constructed both stronger and more economical than the first; others seek to secure the requisite support by splicing the already long piles; others again increase the number of piles, believing that the splicing is uncertain and dangerous, and this last is generally considered as the best practice. Piles from 60 to 90 feet in length can readily be obtained and are driven without difficulty. The usual practice is to stop driving when the pile sinks from one to two feet at the last blow; this would hardly seem to furnish a safe foundation to the novice, but allow one of these piles to stand over night, and the engineer will find, that soft and silty as the material penetrated may be, heavy driving will be required to simply start it again. The settling to place of the material and its friction over a large surface explains this resistance; but if the driving is continued, by rapidly succeeding blows, the pile will commence to sink again as lively as before; the soil has been loosened about the pile and the only resistance practically is that at the point of the pile, which is exceedingly small. To the question,—Will not the vibrations resulting from the passage of a train bring about the same sinking?—Experience answers, —No. The vibration, from this cause, is not powerful enough, does not continue long enough to do much, if any damage, and the soil has time to close around the pile before a repetition of shock from the same cause.

The writer has extended experience in driving piles

MOBILE RIVER BRIDGE; PLAN AND ELEVATION OF PIVOT-PIER.



to great depths in these southern swamps; he has found that a pile driven 50 or 60 feet below the surface will have ample support to bear any load that may come upon it, when in rows of four piles each, with rows 12½ feet apart. In forming the foundation for an abutment or pier, the base should be made broad and the piles driven from 2 to 2½ feet apart. In driving piles for a trestle, across a bayou about three miles from Mobile, the writer found it difficult to keep the piles down; they would lift slowly an 1800 lbs. hammer resting on the head of a pile; and if the hammer was removed the pile would shoot up 8 or 10 inches. Satisfied that the point of the pile was in quicksand, it was determined to remove the pile and drive it butt downward, after first cutting a long tapering point. (Rankine says all piles should be driven in this manner). No further trouble was experienced, the quicksand, exerting a downward force over a large surface, prevented the pile from lifting and the piles were so driven, butt down, nearly across the bayou.

In extending the M. & M. R. R. to Mobile, from the Tensas River, the distance across the swamp by the most practicable and comparatively economical line was only about 14 miles-instead of the 21 miles previously mentioned. But this line crossed the Tensas River, where more than 2,000 feet wide, the Mobile River, for 1,000 feet, five smaller streams or bayous requiring drawbridges, and numberless small bayous requiring pile trestles, at least temporarily. Notwithstanding these natural difficulties the R. R. Company determined to build, and after careful survey and extensive borings, the location and general plan of construction, was decided upon by Col. G. Jordan, the Chief Engineer. Embankments of earth were to be formed wherever possible; pile trestles were to be used across non-navigable streams and in the approaches to all bridges and between the large bridges, the main rivers being only 2¼ miles apart. This latter design was to save time in the completion of the work. Cushing cylinder piers were adopted for the Tensas River' piers, and screw-piles in the piers on the Mobile River; at both rivers the abutments were to be of brick resting on timber pile foundations. The trusses were the combined wood and iron Warren girder for the Tensas bridge, and Post's Patent combined wood and iron for the Mobile bridge.

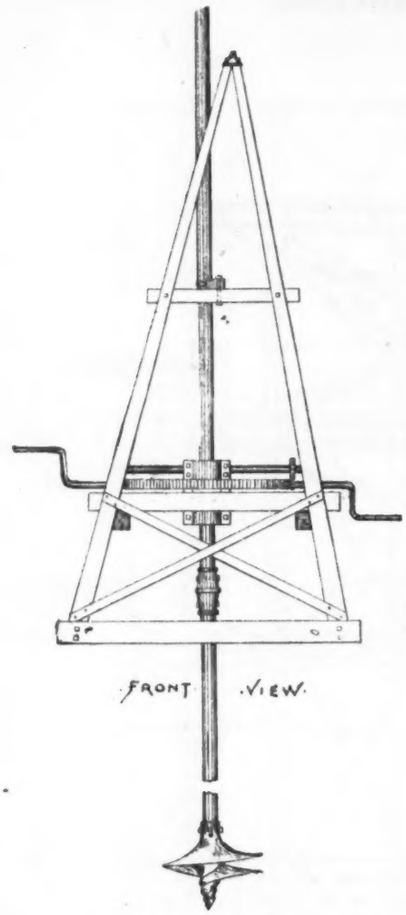
Contracts were closed with Boynton & Bros. for all earthworth, pile trestles and foundations for the Tensas River bridge, and the abutments of both bridges; with the Louisville Bridge Co. for the superstructure of the Tensas River bridge, and with McMary, Claflin & Co. for the screw-pile foundations and the superstructure of the Mobile River bridge and the five small drawbridges. It devolved upon the writer to superintend nearly all the pile-trestle work, the five smaller bridges and the Mobile River bridge, and detailed and illustrated description of this work is now given. Although not immediately under his charge, a general description of the Tensas River bridge is added, neither of these difficult and interesting structures having as yet received more than casual notices.

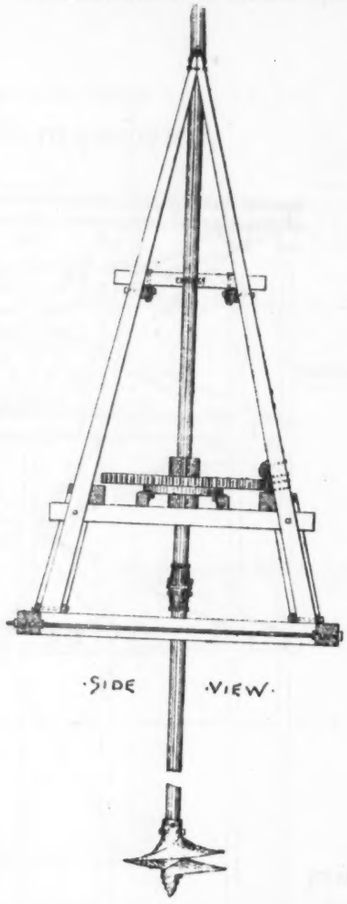
McMary, Claflin & Co, relet the screw-pile foundations to Gen. Wm. Sooy Smith & Son; the designs for the piers were made by the engineers of the company, and the plant necessary to put them in, by Gen. Wm. Sooy Smith. Each pier, except the pivot-pier, was composed of eight solid wrought-iron shafts, 6 inches in diameter, arranged in two rows of four piles each. The piles in each row were 8 feet apart, and the two rows 9 feet apart; these piles were capped with heavy cast-iron members made up of two end pieces, over the end piles, two side pieces resting on the two piles in the front and back rows respectively, and two connecting intermediate pieces. The piles were strongly connected at intervals by girt-frames, and braced horizontally and vertically by diagonal tension rods with swivels. Each girt-frame was composed of cast-iron I-beams, connected by suitable collars snugly fitting the piles. Thus in any one horizontal plane, there were six I-beams in the row of piles, and four I-beams connecting the rows, and six diagonal tension rods. Two of these frames were let down over the piles, after they were screwed down to the required depth, and then connected with each other and the capping pieces by the tension members. The capping pieces were flange-bolted, and the collars and I-beams were also securely bolted. On top of the caps, rolled I-beams were fastened by bolts, and there supported a thick cast-iron cap, forming the bridge-seat on which the end-posts of the truss rested.

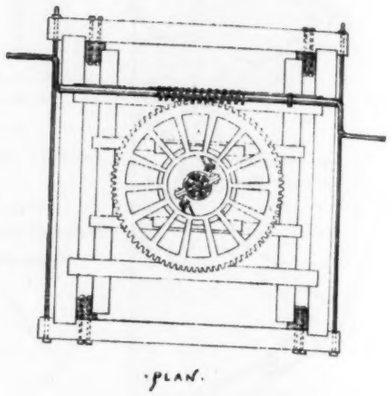
The pivot-pier was composed of one central pile, 8 inches in diameter, and ten 6 inch-piles in a circle; these were braced by a central piece, let down over the center pile, with short radiating arms; to this "spider" flanged cast-iron arms were bolted extending to and connected with the outer piles. These outer piles were connected at the top by a casting and again connected with the center by radiating arms. A large pin dropped vertically into the central cap formed the pivot of the draw and supported the greater part of the weight. As the illustrations, in connection with the description given, make the general design sufficiently plain it only remains to describe the method adopted in sinking these piles.

Each pile was made of a solid wrought-iron shaft in sections, which were coupled together by cast-iron sleeves strengthened by wrought-iron bands shrunk on. At the bottom was a cast-iron screw-disk, 4 feet in diame-

MOBILE RIVER BRIDGE; SCREW PILE MACHINE.







ter; and connected with the pile by two steel pins each 1⅛ inches in diameter; each section of the pile was also fastened to the coupling sleeve by two similar steel pins. The general length of the bottom sections was 22 feet 6 inches; this, being connected with the screw-disk, was first put in position by the machine to be described, and, when accurately located, another section was connected. Around the pile was now put a wrought-iron jacket, made in two parts with flanges; in the interior cylindrical portion of this jacket, wrought-iron blocks were placed, having a steel, serrated face and the two halves of the jacket were then bolted together. The screwing down of the pile was accomplished by the machinery illustrated which was designed by Gen. Wm. Sooy Smith.

A pyrimidal frame of timber well braced and with iron tie-rods was built as shown. This supported a large cog-wheel turned by a worm-screw, the power used being hand power only; the large wheel had a small, central, circular opening, with two projecting lugs carrying friction rollers, the latter spaced so as to bear against the flanges of the jacket surrounding the pile. When the power was applied the jacket and the pile turned, and the auger-shaped disk at the bottom of the shaft penetrated the sand. This operation was continued until the shaft showed signs of twisting (which it did in one case), or until the steel teeth would shave off strips of iron from the pile, showing that the resistance was too great for the machine.

The central shaft of the pivot-pier was 8 inches in diameter and the screw-disk was 6 feet across. The great difficulty encountered in sinking this, and the slight relative depth reached show the rapid increase in resistance due to the enlargement of the disk. As all the iron-work was previously fitted to occupy certain positions, it was essential that all the piles should be accurately located and sunk vertically; both of these requirements were somewhat difficult of attainment; although a few collars did break and had to be replaced by divers, the general accuracy in this work was creditable to all concerned. Another troublesome matter was the lowering of the fully connected girt-frame to the bed of the river, sliding on the piles; the fit of the collars was close and the least deviation from the horizontal in sinking caused the frame to bind on the piles. After much trouble on this account, in building the last pier, a rigid frame-work was first constructed and the girt-frame lowered by screws.

The total width of crossing from shore to shore was divided into seven spans, by two brick abutments and six screw-pile piers, including the pivot-pier and counting the draw as two spans. The length of spans was as follows:—No. 1, 141 feet 1½ inches; No. 2, 142 feet 3 inches; No 3, 130 feet 0 inches; No. 4, 130 feet, (these two making the draw-span of 230 feet); No. 5, 142 feet 3 inches; No. 6, 142 feet 3 inches; No. 7, 141 feet 1½ inches; total length, 969 feet, 0 inches. The piles, bolts, bands on the connecting sleeves, the I-beams on top of the piers and the tension-rods were all wrought-iron; all the other parts in the piers excepting the steel pins connected the shaft-sections, were cast-iron. The average weight of the cast-iron screw-discs was 1,500 pounds; for the centre pile of the pivot-pier, 4,181 pounds, average weight of bottom section of piles (94 pounds per lin. foot), 22 feet 6 inches long, was 2,115 pounds; the top sections varied in length but weighed the same per lineal foot as the bottom.

The quality and character of iron in each pier was as follows:—

material in these swamps that is worthy of note. The beds of the large rivers are commonly composed of sand, and on either side are unknown depth of silt, the latter comparatively free from sand. The beds of the bayous, which have no current other than that due to the tides, differ from the river beds in having a bottom composed of the same material as the adjacent swamps.

In regard to time expended in sinking the piles, etc., Pier No. 6 was completed before the writer was placed in charge, and, owing to the usual delays in starting a work of this kind, took a longer time than any other. The first pile of Pier No. 5 was put in place June 17, 1871, and the sinking of all the piles in this pier was completed on July 8; the average being 5.65 feet per day. Pier No. 4: first pile set July 12, sinking completed July 28; average depth sunk, 7.34 feet per day. Pier No. 2: first pile set Aug. 23, completed Sept. 26; average, 3.90 feet per day; in this pier we could not get the last pile down its full length, the steel pier of the follower used in sinking the last few feet having broken off, it was necessary to cut 3.20 feet off of the head of the pile. Pier No. 1: first pile set Sept. 27, finished Oct. 14; average depth sunk 6.98 feet per day. Pier No. 3, the Pivot-pier, was commenced on Aug. 22, but owing to inadequate means of handling the larger members and for sinking the girt-frames, this work was much delayed and practically was not completed until Dec. 6, 1884. When the center shaft was finally sunk as far as it could be forced, 5.36 feet of it had to be cut off in position, requiring much time and labor.

The establishment of a base line for triangulation on

No. of Pier.	Cast-Iron LBS.	Wrought-Iron LBS.	Steel LBS	Total LBS.	Avg. length of Pile and Screw disc FT.	Avg. depth Sunk below River bed FT.	Total depth of all piles below river bed FT.
1	59,635	47,368	336	107,339	44.49	15.70	125.60
2	59,635	45,336	336	105,307	41.79	17.08	136.63
3 pivot	136,431	54,893	462	191,786	40.24	18.49	203.34
4	59,635	45,466	336	105,437	41.96	17.60	136.02
5	59,635	43,282	336	103,253	39.14	15.79	124.78
6	59,635	40,906	336	100,877	36.33	15.54	124.34
	434,606	277,251	2142	713,999			850.71

The greatest average depth sunk below the bed of river was 18.49 feet and the least depth was the center pile of pivot pier which was 14.31 feet.

The abutting ends of the pile sections were planed to a true surface giving a perfect and full bearing; the tops of the piles were required to be exactly at the same elevation; in two or three cases this was impossible and the tops had to be cut off by chisels. In order to insure a proper bearing on the heads of the pile, small holes were bored in the top castings and melted lead was poured in to fill any vacancies between them and the pile.

There is one peculiar feature in the stratification of the river bank was extremely difficult; the ground was so springy that piles, 6 or 8 feet long, had to be driven for the transit stations. Owing to the low level of the swamps the transit point itself was usually under water, the piles surrounding it being driven on the angles of a small equilateral triangle. The slight error in the ultimate measurements was a subject for congratulation when the circumstances are considered. The abutments alone were located by triangulation, the piles in each pier were fixed by measurements with a fine steel piano-forte wire, No. 10; this wire was found satisfactory and was altogether used. To mark the wire fine tarred string was used, carefully wrapped, al-

though shoemakers' wax was found later to be somewhat better. A wire of this kind when under a tension of 15 lbs. is practically straight, entirely accurate and reliable, and was better than a purchased 450 feet steel tape; especially as the writer was requested to test this tape for himself when the question was asked as to whether it was graduated when stretched on a flat surface or when suspended and under the definite tension of 15 lbs. carefully marked on a spring balance sent with it. It was found on trial that the center of this tape could not be lifted from the ground with 25 lbs. tension.

Recent Inland Navigation Abroad.*

BY M. B. L. TAPSCOTT.

The subject I am about to bring before you is one of which I shall treat by giving more of an indication of what is going on around us than a statement of the smaller details pertaining to the various combinations which have made the possibility of these great undertakings a reality.

The Suez Canal having been brought to so successful a conclusion has set the popular mind to once more taking up the natural forces of nature lying at our very doors. This canal, rendered possible by the great mechanical success of the early part of this century, was not only accomplished but has been maintained in a state of efficiency, no doubt at great cost, for a sufficient number of years, to show the feasibility of such undertakings.

The length of the Canal is 97½ miles from sea to sea, and it passes through no less than four lakes of sufficient depth to have required but little labor; the width at bottom is 72 feet and at surface 197 feet, and, as it is only wide enough for one vessel to proceed at a time, passing-bays are provided. Now its practical utility has been demonstrated, and a sufficient number of years has elapsed for the steamships sailing to the part of the world with which it communicates to be replaced by new ones specially constructed for passing through it, and thus it is from these various causes so great a success that it is insufficient for the traffic available. Being principally through a sandy tract of land it is only by continual dredging that it can be kept open for vessels drawing 25 feet with a length of 400 feet. Vessels passing through the canal had, in the year 1882, an average speed of two miles per hour; that is, for the time occupied in transit though, whilst moving, the speed was 5½ statute miles; and when it is considered that very few of these vessels do less than 11½ miles and many of them very much more, it shows what opportunity there is for improvement. It is, however, recorded that a speed of over 8 miles per hour has been attained.

The concession granted by the Porte for the canal provided for a sectional area of nearly twice what has been made; the width at a depth of 26 feet being given as 144 feet, instead of 72 feet as constructed. It has been found necessary to protect the sides, and artificial stone is being used for the purpose. This was rendered necessary by the flat shoulders forming the sides enabling the water to rush over them, which not only dragged back the vessel but denuded the bank. Of course the original object was to avoid any costly system of keeping up the banks: it appears, however, that the result has not been as expected, and it is open to serious consideration whether there was not sufficient reason for having an elliptical form of canal, and letting the first cost include stone facing to the sides; the quantity of excavation, a serious item, would have been materially less, and the utmost effect would have been got out of the area.

Modern vessels, like the "City of Rome" and "Alaska," could not pass through the canal, and its cross section is only three times the immersed section of the ironclad "Warrior."

In the year 1882, the total amount of shipping passing through the canal was 7,122,123 tons (of which 5,795,584 tons were British), and this gave a transit revenue of £2,421,835.

The rise of tide in the Mediterranean is 2 feet, but at the Red Sea it is 3 feet, with exceptional tides having a rise of 5 feet 6 inches, affecting the canal as far as the Bitter Lakes, a distance of 20 miles inland.

The successful completion of the Suez Canal and its rapid adoption as the main route to the East, have shown the adaptability of the merchant service to new waters, and have made it evident that a canal across the Isthmus of Panama would confer equal benefits on the West. Already the necessity for such communication has resulted in the construction of a railway.

The proposal appears to have every prospect of a financial success, whatever its cost. Connecting two great coasts by the economical means of water communication, thus doing away with the necessity of transhipment, it will tend to make the western coast of the American continent—having, as it has already, the greater natural advantages—the greater and more important part of that continent. The difficulties are great, though there is nothing perhaps to do but what has been done in isolated instances before, yet the whole work is of a magnitude at present unapproached. The machinery which enables the appearance of success, being yet subject to necessary improvement—the course lying through the great backbone of mountains extended through the continent—the amount of soft material to be removed by a slow process—the placing under control of the torrents which are liable to sweep everything before them at certain seasons—the great rise and fall of tide probably rendering locks a necessity—the difficulty of climate—the absence of pure water and those simple things that in temperate climates are invariably at hand—in fact, the necessity of first creating a habitation for man—all these are obstacles which are patent to every observer.

The course of the canal is from Colon on the Atlantic to Panama on the Pacific Coast; and first of all it is found that at the Atlantic seaboard there is a rise of tide of about 2 feet, whereas at the Pacific side there is 13 feet 3 inches, the times of high water in the two oceans not coinciding; so that there would, if not prevented, be at times a strong flow of water along the canal, making navigation in such a narrow channel extremely dangerous.

There have been various schemes brought forward, each having some special advantages, to utilize the river San Juan, the Lake Nicaragua, &c.

Amongst the natural difficulties of the route already presented is that due to the River Chagres, necessitating the alteration of its course and the construction of a dam of considerable proportions. The canal as being constructed is about 45 miles in length, and it was at first proposed to do without locks; but it has since been found that, owing to the necessity of obviating a current, it may be necessary to have locks both at the Atlantic entrance and the Pacific, for the reason just given.

The cost of the undertaking is put forward as £25,000,000, but some authorities would make it £34,000,000. Now, assuming a traffic of 4,500,000 tons a year, paying 12s. a ton, and allowing for the same working expenses as at Suez, there would be an annual profit of 5 per cent. It was intended to carry out the work in eight years, but already three years of that time are gone, and two-thirds of the capital expended, for a very small proportion of work done.

In the beginning of 1881, the engineers arrived at Aspinwall and commenced the necessary preliminaries of setting out the line, examining the site, and preparing for actual work. The cutting may be divided into sections: starting from Colon, to beyond San Pablo it does not exceed 43 feet in depth, and is generally less, but further on the ground rises, and after reaching Gorgona, about 25 miles from Colon, the depth varies from 65 to 124 feet. Passing through Obispo, Emperador, Culebra, and Paraiso, between the 25th and 27th miles, exceedingly difficult country is met with, the cuts in Emperador being 194 to 252 feet in depth, and at Culebra, the summit, 286 feet. The work at Paraiso will also be very heavy, the excavation varying from 98 to 229 feet in depth; but after Paraiso and the 37th mile the cuts become moderate, and are reduced to 49 feet or less. The route then follows the course of the Rio Grande, and leads to the sea at its mouth between the 42nd and 43rd mile, the remainder being effected by dredging. A large amount of work has to be done by hand before the machine can be set to work. From Colon to Gatun was intended to be excavated first to a depth of 8 feet, with a width of 100 feet to allow dredges to work; by this means, the depth of 22 feet and additional width of 65 feet were to be obtained.

The work is given out in several contracts:—One, from the American side, to a distance of 7½ miles inland; another, the Culebra section at the summit of the route, involving 4,600,000 cubic yards of excavation to be taken down to a level of 246 feet above the sea. The contractor's plant for this section consists of 10 locomotives, 300 tip wagons, and 450 tons of rails, all of the American type; the work was to have been done in 26 months. Another contract reaches from the mouth of the Rio Grande to a point in the neighborhood of Paraiso, about five miles in all. The Company have also executed considerable work, having laid 5½ miles of railway, and, for their permanent works, reclaimed 28 acres of land from a marsh, which, being on the coast, offered a more healthy site than further inland, and provided wharfage.

The Chagres River is one of the most serious obstacles to the work, necessitating a diversion of its course and the construction of a reservoir to hold the storm water and prevent the torrent which results in the rainy season from sweeping away the canal; a dam will be constructed across the valley from hill to hill (Cerro Cruz to Cerro Obispo), having a total length of 2,600 feet, and a height of 100 feet, and being capable of retaining 880,000,000 cubic feet of water, which will then be available for supplying the canal. The greatest rainfall noted has been about 32 inches in a month. The amount of plant is considerable; of 60 locomotives ordered in Europe 20 were at work at the beginning of 1883, and 27 have been sent out in July last year; about 2,000 railway trucks were ordered, and 600 have been sent out; while out of 50 excavators 18 have been sent. In July, 1883, 6,000 men were employed on mere preliminaries; the climate was very trying, but the cases of illness had then fallen to 14.30 per cent., and the mortality to 5.5 per cent.

In 1885, the town of Panama had 20,000 inhabitants, without counting the adjacent colored town of Pueblo Nuevo; the drainage of the town depended upon the torrents of rain which fall for seven months of the year nearly every day, from April to November. There is no rain in the dry seasons, and three buckets of water are worth sixpence during February and March. A company has, however, now been formed for bringing water in pipes from the Rio Grande. The temperature from December to April is from 80 to 84 degrees, and during the remainder of the year the heat is oppressive, owing to dampness of air and want of sea breezes. By March, 1883, 222,000 tons of material had arrived at Colon, of which 92,000 were for the canal, and it is estimated that of machinery and tools, £2,000,000 worth were credited to the Company; the plant has been mostly sent from the Continent, this country having contributed very little.

*Read Oct. 8, 1884, before the Liverpool Engineering Society.

The difference in level of the oceans has been reported on by the engineer, and he states that at Colon the difference between high and low water marks is no more than 23 inches but at Panama, on the Pacific, the average variation in the height of the water is 13 feet 3 inches, and the maximum no less than 19 feet 8 inches; moreover, high water at Colon is about nine hours later than at Panama, therefore half-tide at one place corresponds with high or low water at the other, and there may be a difference of tide level between the ends equal to half the rise on the Pacific Coast. By comparison with the Bay of Biscay, he estimates the speed of the current would be from five to six miles an hour in the uninterrupted portions of the channel, and greater when the cross-section was reduced by the passage of a ship. The amount of excavation done to July 31st of this year amounted to 9,501,825 cubic yards, out of a total of 117,900,000 cubic yards.

It is a curious fact that Holland and Belgium have not only utilized available water for canals, but are also well supplied with railways. Belgium has a mile of waterway for every ten square miles of land, and the length of main roads is but four times the length of waterways. From a very early time Holland has been noted for its water communications, but the desirability of making them available for large ships has led to recent works of great importance. In 1819, a passage was commenced for large ships from Amsterdam to Neiudiep near the Helder, affording communication with the German Ocean, and was completed in 1825, at a cost of £1 000,000; the length was about 50½ miles, the depth 20 feet, and the width at surface of water 124½ feet, narrowing down to 36 feet at the bottom. The canal recently constructed is from Amsterdam through the Isthmus of North Holland to the North Sea; it is 26 feet deep and 197 feet wide, and had been available previously for vessels of a certain size. It presented difficulties of an unusual kind and of so grave importance that, during the early part of this century, the North Holland Canal, of a length of 50 miles, was constructed to accomplish the same purpose as that attained by this with a length of only 15½ miles, and passing through, for the most part, a series of lakes, and effecting the drainage of a very large area of waste, which has resulted in extensive reclamation. There was also the difficulty of maintaining an entrance from the sea, which has been overcome by means of extensive sea walls and the cutting of a channel of a depth of from 40 to 50 feet through the sandhills on the coast. To maintain a certain level of water as regards both the sea and the land, drainage locks are provided at each end, together with pumping arrrangements and branch canals. The main canal is crossed by three swing bridges—two railway and one public road.

Public attention in France has been considerably directed towards improvements in its waterways, and amongst the many propositions brought forward is one for a navigation from Toulouse through Narbonne to Bourdeaux, involving the improvement of the River Garonne for a distance of 270 miles, rising to 500 feet above the sea level at its highest point, and depending for its supply of water upon the Garonne and minor streams flowing into it. Being of a sufficient size to enable large war vessels to safely pass through, and so avoid the dangers of the Bay of Biscay and the voyage round by Gibraltar, and giving a second access to the Mediterranean, and thus, from a strategic point of view, being of great moment and neutralizing the importance of the old "key to the Mediterranean," it also shortens the route to the far East: it is said further that it would enable the grape vine to be cultivated along its banks. There are, however, many difficulties, one of the chief being the height above sea level, which necessitates a considerable series of locks. A Commission was appointed to examine into the project, and has agreed as to its practicability, but declined to give an opinion as to its being worth the expense; the estimated total cost being £56,660,160.

Improvements in the Seine have resulted in a large increase in the quantity of English coal delivered in Paris, which now in fact amounts to half the total supply. These improvements consisted in the construction of training walls from quarter tide to half tide and high tide level for a distance of 30 miles (from La Mailleraye to Berville,) the walls being 980 feet apart at the upper end, and 1,450 feet at the lower end. The channel so fixed has been deepened so that vessels drawing 21 feet of water can navigate to Rouen; but though in the upper part of the river so much good has resulted, the effect below Berville is very serious, as it is found that the estuary is silting up, and that the port of Havre is endangered, so that it is now proposed to make 10 miles more of training walls to the sea, and these will be costly to maintain.

The large quantity of coal brought to Paris due to the Seine improvements has caused much complaint from the Northern coal proprietors, and a scheme has been brought forward for a canal to Paris, so as to place them on an equal footing with, or rather, give them a preference over, the foreign merchants. The Dunkerque to Paris would be shortened by 68¾ miles; the canal, having a width of 56 feet 8 inches, would take a direct course *via* Arleux, Péronne, Main and Noyon, and is estimated to cost £4,200,000. The average cost of canals in France is £7,200 per mile.

Russia has an extensive system of ordinary canals and water way, enabling goods to be sent from the frontiers of China to St. Petersburgh, 4,500 miles, between the Caspian and Black Seas, and also between the Baltic Sea and Arctic Ocean—the Caspian and Baltic connection being a canal between Astrakan and St. Petersburg. At the present time, however, a ship canal is in course of construction to enable direct delivery of goods from Cronstadt to St. Petersburg, and avoid the loss and risk of the present system, by which the goods are transferred to barges: the present canal is 9 feet 6 inches deep. The new works were commenced in 1876, and are now about two-thirds done: starting from the mouth of the Neva, and proceeding southward for nearly two miles, a navigable width of 207 feet will be carefully embanked; thence taking a wide curve the channel will join the canal which goes direct to Cronstadt, and from the same point a branch will be made to meet the Neva above St. Petersburg. It will have a uniform depth of 22 feet, being excavated in an easily worked soil, composed mostly of clay, sand, and gravel, of which a total quantity of about 63,000,000 cubic yards will have been removed. This material has been used for the extensive embankments, the foundations of which were laid with a double row of timber pontoons filled with gravel, their internal faces being then covered with planking and plastered with clay, the space thus formed and lined was filled with liquid clay by pumping apparatus, and the contained water was allowed to escape by openings provided for the purpose, The sloping sides of the dyke are protected only by dry masonry resting on a bed of ballast, no provision having been made against sand. The plant employed comprised 10 dredgers (seven of them of English make), capable of dredging 188,356 cubic yards in ten hours, 86 barges and lighters capable of transporting 153,038 cubic yards, 12 tugs of a total of 600 horse-power, one steamboat and two steam launches, two floating dredgers, one excavator, seven locomotives, and centrifugal exhaust pump.

A scheme has been propounded for connecting the Gulf of Siam with the Indian Ocean, and it is proposed to take advantage of the present rivers and start thence, following the bed of the River Tajons to the Gulf of Siam; the canal to be cut would be 66 miles long, and it is estimated to cost £4,000,000.

It has been proposed to cut a canal across the Peninsula of Florida. It appears that the annual loss of vessels going round the peninsula is large, and this fact taken in connection with the great saving of distance by the projected route, has led to the consideration of the scheme, which is estimated to cost £1,000,000. The Peninsula is 373 miles long from north to south, and 124 miles wide from east to west. Its formation is remarkable, being composed of a succession of curving ridges descending towards the south, at the foot of which lies a bed of alluvial soil partly submerged; the foundations of these ridges are a corresponding number of coral reefs, which will give some trouble, especially as they will have to be cut through at the highest point. Another serious difficulty is formed by the banks of oyster shells which bar the entrance to every creek and river on the western side, and are extremely hard to remove. Off the coast are sand banks and coral reefs. The streams of the peninsula have so little slope that there is scarcely any current. The largest river is the St. John, which it is proposed to use as the Atlantic entrance to the canal, and this will require to be protected by breakwaters; on the other side, the river Suwanee could be utilized.

Velocity of Projectiles.

The manner of ascertaining the velocity of a projectile was lately described and illustrated at the meeting of the New York Electrical Society by Henry A. Sinclair, electrician at the United States Ordnance Proving Ground at Sandy Hook. One of the Boulenge chronographs used at the proving ground was set up in the lecture room and Mr. Sinclair demonstrated its quickness and accuracy in determining the velocity of a pistol ball. The instrument was described as being very simple and very easy to work. It consists of an upright brass tube, supporting two electro-magnets, one above the other. When a test is being made an electric wire connects one of the magnets with the point of firing and another electric wire connects the other magnet with the target or objective point of the projectile. A long rod is suspended from the first magnet and a short rod hangs from the second one.

The projectile in leaving the gun cuts the first wire and the broken circuit releases the long rod, which drops downwards. When the projectile strikes the objective point the second wire is broken and the short rod falls, striking a spring which causes a knife-blade to mark the descending long rod. The space from the base of the long rod to the indentation is then measured, and by the fixed law of falling bodies the time taken by the projectile in going from the gun to the target is ascertained, and from that the velocity is figured. Mr. Sinclair took a good sized revolver, loaded it with 3½ grains of powder and a bullet weighing 133 grains and fastened one end of the wire attached to the first electro-magnet across the muzzle. He then fired at a wired target in a tubular shooting gallery about 4 feet long. The time of the transit of the bullet was determined from the mark on the long rod, and it was speedily announced that the velocity of the bullet was 156 feet per second. A second trial with the same instrument showed a velocity of 207 feet per second.

"Why is it desirable to ascertain the velocity of a projectile?" asked a member of the society.

"Because," replied Mr. Sinclair, "it is a means of comparing the power of a gun, of comparing different kinds of powders and projectiles, of determining their energy and approximately their range and penetration into

iron plates. Had the officer in command of the Monitor at the time of her memorable encounter with the Merrimac known what his guns would stand he could have sent projectiles clear through the iron-covered sides of the ram. He used only six or seven pounds of powder in a charge when his guns would have stood charges of 14 or 15 pounds. Few persons realize how much energy a large projectile possesses. A 12 inch shot weighing about 700 pounds, and traveling with a velocity of 1,500 feet a second, would strike as hard a blow as a railroad train consisting of locomotives and five or six cars (weighing about 100 tons) moving at the rate of 57 miles an hour.

Attempts were made to ascertain the velocity of projectiles as early as 1740, and in 1840 electricity was first used for that purpose. By the Schultz chronoscope, which Mr. Sinclair said was the most accurate instrument of its kind, intervals of time can be measured from 30 seconds to one five-thousandth part of a second Mr. Sinclair exhibited specimens of the fuses used to fire large guns, and also showed several varieties of powder. Some of the grains were as large as a hen's egg. The method, by which the pressure exerted by an exploded charge on the inside of the gun was measured, was explained. The lecturer said that guns had been tested at Sandy Hook up to a pressure of 107,000 pounds per square inch, but that was extraordinary. The average pressure on a gun was about 40,000 pounds to the square inch. The velocity of projectiles from large guns ranged from 600 to 2,400 feet per second.—*N. Y. Times.*

The Surveyor and the School-Ma'am.

A FACT.

BY H. E. GEORGE.

It was a land-surveyor,
With his mysterious load
Of bright, three-legged instruments,
Came striding down the road.

And just before the district school
He paused to take a sight;
And all the children came and stared
At his theodolite.

The little school-ma'am hurried out,
To see what caused the stir;
And one and all they took the man
For a photographer.

"And oh!" the little schoolma'am cried,
"How happy I should be
If you would take our likenesses—
My scholars all, and me!"

The man (he was a wily wag)
Replied: "'Twould cost a sight
To photograph a district school
With a theodolite!"

But still the little school-ma'am begged,
And longed to have her way.
She searched her pocket-book, and found
Two dollars she could pay.

He said: "Although that is'nt much
For taking such a view,
You're so *hard up* for likenesses
I guess I'll make it do!"

The school-ma'am scrubbed her little ones
With lavish soap and care,
And straightened down their pinafores,
And "slicked" their stubborn hair.

And then it was a goodly sight
To view that stiff thirteen;
Six boys and girls on either side,
The school-ma'am in between.

His big bandana then he spread,
And 'neath it took a look;
And "sighted" them sufficiently,
And laughed until he shook.

The picture promising to send,
Nor waiting for the pay,
This graceless wight took up his traps,
And hurried on his way.

The picture—it was but a sketch
In pencil, nothing more,
Of those thirteen confiding ones
Grouped round the schoolhouse door.

And underneath this *photograph*
Was writ: "This is the sight
I took by Smithville's district school,
Through my theodolite."

SALISBURY, CONN.

—*The Independent*

OUR MATHEMATICAL COLUMN.

THE SIGNS + and − were first used by Christopher Rudolph about 1524. The sign = was employed first by Robert Recorde in 1557, because, says he, "noe 2 thynges can be moare equalle."

THE BINOMIAL FORMULA is said to have been discovered by Sir Isaac Newton from observing the powers of the number. Thus the square of 11 is 121, the cube of 11 is 1331, and the fourth power is 14,641, and the digits of these are the same as the coefficients of the expansion of $(a+b)$ to the corresponding powers.

HIPPOCRATES, who lived about 300 B. C., was one of the best geometers of his time. He showed that the area of the crescent, bounded by one half the circumference of one circle and one-fourth the circumference of another, is equal to that of an isosceles right-angled triangle whose hypothenuse is the common chord of the two arcs.

THE PRINCIPLE of least restraint, as stated by Moseley is as follows: If any number of forces be in equilibrium, among which are a given number of resistance, then is each of these resistances a minimum, subject to the conditions imposed by the equilibrium of the whole. In other words resisting forces generated by applied pressures are no greater than is just necessary to preserve the equilibrium.

GEODETIC computations are now generally based upon Clarke's elements of the elliptic spheroid, whose values are the following:

Polar diameter in feet	41,710,242
Equatorial diameter in feet	41,852,124
Quadrant in meters	10,001,887
Excentricity	0,082,227

From these values the radius of curvature and the lengths of the degree for any latitude are computed, and the constants determined for use in geodetic formulas.

MR. C. H. GILLETT, of Appleton, Wis., sends us a very convenient formula, which has proved useful to him for parting off land in trapezoidal fields. To explain it in its general form let $A\,B\,C\,D$ be any trapezoid, the sides $A\,B$ and $C\,D$ being parallel. Let the sides $A\,B$ and the angles A and B be measured. Then for a given area the formula for the length of $C\,D$ is

$$C\,D = \sqrt{A\,B^2 - 2\,\text{Area}\,(\cot A + \cot B)}$$

If A or B is greater than 90 degrees, the sign of the cotangent is of course negative. For example if $A\,B = 40$ feet. $A = 80$ degrees, $B = 75$ degrees, and if the area to be parted off is 1 200 square feet, then

$$C\,D\sqrt{1600 - 2400\,(0.1763 - 0.2679)}$$

whence $C\,D = 42.66$ feet.

After finding $C\,D$ it is easy to calculate the sides $A\,C$ and $B\,D$ and the perpendicular distance between the parallel sides $A\,B$ and $C\,D$. This rule does not seem to be given in the text-books, and will no doubt often prove serviceable.

"A READER" writing from Tarrytown, N. Y., says that he has solved Problem 2 by Rankine's formula, and finding that the velocity of the stream is somewhat smaller than by Weisbach's formula, he wishes us to point out the cause of the discrepancy. This is due to a variation in the coefficients of friction used in the two cases. These coefficients are determined by the discussion of experiments, and authors do not agree as to the values to be assigned to them or as to the manner in which they vary with the velocity. The coefficient used in Weisbach's formula was an average one, and probably could have been rendered more precise, although it was scarcely necessary to do so for an illustrative example such as Problem 2 was.

MR. JOHN DAVIS of Philadelphia, expresses surprize at the solution of Problem 5, and asks if we are really understood to mean that the value of the pressure P exerted by the gate upon the ship "is that measured by a static pressure of P pounds and not work as measured by pounds feet?" We reply that if P be average pressure and a the distance through which it is exerted the work of the gate is Pa. This is equal to the work of the ship, or

$$Pa = \frac{W v^2}{2g}.$$

The values of P deduced from this equation is certainly the average pressure against the gate and would be measured by a dynamometer as static pressure. If the gate cannot yield at all P is infinite, but if it yield a inches the average static pressure is

$$P = \frac{W v^2}{2\,a\,g}.$$

As mentioned in our solution the maximum pressure will be greater than the average value.

COLONEL ADAMS' interesting letter on the fallacies of the pyramidists renders it necessary to say that neither Symthe or any of his American followers is responsible for the deduction of the hyperbolic base from the dimensions of the King's chamber and coffer. That deduction was made by Dr. H. E. Licks for two purposes: first to show the method employed by the pyramidists in establishing their truths, and secondly to indicate that the heathen or profane measures are just as good as the so-called sacred pyramid measures for making such deductions. In order that the value of x shall be the base of the hyperbolic system of logarithms it is necessary in this case to use the profane cubit, which is a unit that the faithful would never employ. In regard to the method which Colonel Adams has so clearly exposed, Dr. Licks is likewise explicit for he says: "It occurred to me the other day that the logarithmic constants had not been deduced from the pyramid measures; accordingly I set to work inspecting the measurements, combining them and operating mathematically upon them, until finally the search was rewarded." This, together with a proper "screening," seems to constitute the essence of the method.

PROBLEM 6. A triangular pyramid whose base is $A\,B\,C$ and whose vertex is D has $A\,B = 12$, $B\,C = 13$, $C\,A = 5$, $D\,A = 12.21$, $B\,B = 11.18$ and $D\,C = 10.68$. Required the vertical distance of the vertex D above the plane of $A\,B\,C$.

The following solution is by A. M. Haynes, Empire City, Minn. Let O be the foot of the perpendicular required. Draw $D\,E$, $D\,F$ and $D\,G$ perpendicular to the sides $A\,B$, $B\,C$ and $C\,A$ (or to their extensions) respectively; then will $O\,E$, $O\,F$ and $O\,G$ be also perpendicular to the same sides. All the sides of A D B being given we readily find $A\,E = 7$ and $D\,E = 10$. Similarly we find $A\,G = 6$. All the sides of $A\,B\,C$ being given we find $B\,A\,C = 90$ degrees. Hence $E\,O = A\,G = 6$. Then from the right angled triangle $D\,O\,E$ we have $D\,O = \sqrt{10^2 - 6^2} = 8$, which is the required perpendicular.

PROBLEM 7. Required to find the diameter of a drain by Adams' formula

$$\log.\ D = \tfrac{1}{3}\,(2\log.\ A + \log.\ N - 3.79)$$

when $A = 0.43$ acres and $N = 480$.

The only difficulty here is in the manipulation of the negative logarithms, which the following scheme will avoid.

$$\begin{aligned}
\log.\ 0.43 &= -1.00 + 0.63\\
2\log.\ 0.43 &= -2.00 + 1.26\\
\log.\ 480 &= \quad\ 2.68\\
\text{constant} &= -3.79\\
6\log.\ D &= -5.79 + 3.94 = -1.85\\
\log.\ D &= -0.31 = -1 + 0.69\\
D &= \quad 0.49\ \text{feet.}
\end{aligned}$$

PROBLEM 8. A roof whose span is 24 feet and whose rise is 5 feet consists of two rafters, each 3 inches wide and 6 inches deep. Find the load per linear foot of rafter which will produce a compressive stress of 600 pounds per square inch at the most dangerous section of the rafter.

The solution following is by N. Shiraishi, Philadelphia. The effect of the load may be analyzed into two parts, one a direct compression due to considering one-half the total load concentrated at the peak of the roof and the other a flexural stress due to the rafter acting like a beam. These two parts act conjointly to produce the greatest compression at the middle of the rafter on the uppermost fibre. Let W be the total load on the rafter. Then for the first part the total compression is $\frac{13}{10}W$ and the stress per square inch is $\frac{13}{180}W$. For the second part the theory of flexure gives $\frac{13}{12}W$ for the stress per square inch. Then by the condition of the problem

$$\frac{13}{180}W + \frac{13}{12}W = 600$$

from which the total load W is found to be 520 pounds and the load per linear foot 40 pounds.

This result is practically correct but a strict mathematical deduction would find $1.32\ W$ for the compression due to direct stress, and would also show that the dangerous section is not exactly at the middle of the rafter.

PROBLEM 9. (Proposed by A. M. Haynes, Empire City, Minn). Let $A\,B\,C$ be a triangle in which $C\,A\,B$ is obtuse. Let $A\,D$ be a line perpendicular to $A\,B$ drawn from A to a point D in the line $C\,B$. Given $A\,D = 25$, $A\,C = 30$, and $A\,B + B\,C = 100$. Required $A\,B$.

PROBLEM 10. A roof of 24 feet span and 5 feet rise consists of two rafters each 6 inches deep and uniformly loaded. Find the most dangerous section of the rafter.

PROBLEM 11. If the earth is considered as a sphere, find the mean value of its radius from Clarke's elements of the elliptic spheroid stated above.

UNTIL operations were seriously begun at the Kalamaki end of the Isthmus of Corinth Canal no engineering difficulty was expected to be encountered. There, however, the soil has been found to be not so easily removed as at the Corinth end, and blasting has had to be resorted to. At the commencement of 1884 the quantity of earth excavated along the line of the canal was 500,000 cubic meters, and at the close of 1884 about 1,300,000 cubic meters had been taken out, leaving still an aggregate of 8,000,000 cubic meters to be attacked. The engineer says the progress made has been satisfactory, though the completion of the undertaking is not likely to be effected quite so soon as was anticipated.

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THE London *Architect*, of March 21, says:—"At the present juncture it is impossible not to take interest in the long paper which MR. H. G. PROUT, formerly a colonel on the staff of the Egyptian army, contributes to the American ENGINEERING NEWS," and follows with an abstract of the article referred to.

THE ministerial *Journal de Bruxelles* announces that the Belgian Government proposes an improvement in the canal system of that country; the first step being to put the old city of Bruges in direct communication with the North Sea by a ship canal. The estimated cost of this canal is $5,000,000, and the Belgian Government is asked to guarantee an interest of three per cent. for at least two years. The projector of this canal project is M. de Maere-Limander, a Belgian Civil Engineer.

The Coming Meeting of the American Water Works Association.

The American Water-works Association will hold its fifth annual meeting at Young's Hotel, in Boston, Mass., on April 21, 22 and 23.

This association was organized in St. Louis, Mo., on March 29, 1881, with an original membership of twenty; Mr. J. H. Decker, the active Secretary, now reports a total membership of over 150. The objects of the association are, the gathering and exchange of information pertaining to the management of Water Works, for the mutual benefit of water suppliers and consumers, and for the purpose of securing economy and uniformity in the operation of works.

The aims of this association are laudable, and the present standing and character of its membership show that its work is being appreciated. But it is capable of extension and should extend until it embraces within its fold every progressive manager of water-works in this country. It is only by this pooling of common experience that the greater good can be done; and who can doubt the valuable results to be obtained from the sifting and comparison of the practical experience of a majority of the managers of the one thousand water-works already established in the United States?

We have every system of supply and distribution, from that intended for a population of millions, to those meeting the demands of a few hundred consumers. We have the best pumping plant in the world, and our hydraulic engineers and superintendents perhaps exceed in their wide range of experience those of any other country. If we can not from all this mass of valuable data deduce a perfect system of detail of construction and operation of works for water-supply, it is simply because we fail to make proper use of the material at our hand.

But it will not do to get into a rut of practice and stay there; all interested in the advancement of hydraulic engineering must strive to improve, and to perfect the methods of construction and management; and, it is only by knowing what is being done every where else that they can keep abreast of the times and finally arrive at the perfect end.

It is for this reason that we welcome associations of workers, such as this is, and wish to see the ranks swelled until the interest is made a common cause throughout our wide and rapidly advancing country.

The Suakim-Berber Water Supply.

In a late editorial we remarked that *Iron* recommended that the American pump question be referred to the House of Commons for official action. This seems to have been done, for in the proceedings of March 12 we find, in substance, the following:—

The Surveyor General of Ordnance had previously read a letter from the Messrs. Tangye stating that the pumps for the Suakim-Berber water supply could not be obtained for some months in England; to this Mr. W. H. Smith replied that the pumps for the Aldershott Experiments were ordered by Mr. Tweddle of Messrs. Owens & Co. (of England) on May 20, and were completed and sent to Aldershott on June 4, and that the Messrs. Owens made all the pumps for the Caucasus oil-line required by Mr. Tweddle.

Mr. Brand replied that the Aldershott pumps were not duplex and were much smaller than those required for the Suakim route; that Mr. Tweddle had informed him that he had ordered three tests of the large duplex pumps made by the Messrs. Owens, and that he considered them inferior to the Worthington pumps; that the present pumps were ordered on Feb. 25, and the first arrived on March 3, Mr. Tweddle having taken it upon himself to anticipate the formal order, the second arrived on the 10th, the third on the 13th, and the last three were due on March 16.

The London *Globe* of March 14, one of the oldest daily papers in that city, referring to this subject under the head of "American Competition," first sings the praises of free-trade and the advantage gained by England from the world being open to its product while other countries have cut themselves off by an excessive tariff. The *Globe* believes that thus far England has had the best of the bargain, but the rumors from America, that public opinion was gaining strength as to the advisibility of reducing American fiscal barriers, causes it to ask what effect these reductions are likely to have on British interests.

We give the remainder of this editorial in full as follows:—

"A reduced American tariff means closer competition against this country in the neutral markets of the world. Every diminution of that tariff will give new impetus to American productions, and will be equivalent to additional tightening of the screw of international competition. Unfortunately for this country, there are other elements in the industrial condition of the States which will act to our detriment, One of these is the silver question, the other is the superior mechanical equipment of American industry, and the more satisfactory relations prevalent between capital and labor in that country. But our great fear as to the industrial future of this country, in its inevitable rivalry with the United States, lies in the more perfect organization of our competitor. The American is *par excellence* a mechanical inventor. His natural ingenuity, fighting against the artificial enhancement of prices, resulting from the prevalent fiscal system, has driven him to seek relief in mechanical assistance. He had compensated for dearness of material in cheapness of production. Every workman in every manufacturing center is stimulated to study and master the machine under his charge with a view to improving it. Mechanical development is part of the character of the nation. We may be sure that the country which produced the grain-elevator, the *oil-pipe pumps*, machine-made watches, the high-speed printing machines, the ring frame, and other inventions without end, will develop still greater creative powers under the stimulus of a growing export trade. *Where shall we be then?* The relations also between the capitalist and labor classes in the States are more of a nature to encourage production and to develop the capacities of rising generations. Greater attention is given to the physical and moral well-being of the American artisan than is considered to come within th sphere of duty of the British or European manufacturer. A certain spirit of emulation pervades the laboring classes on the other side of the Atlantic, in the place of the levelling down to a general average which prevails in this country. The American artisan works for himself, knowing that his success will be recognized and encouraged. He seeks to rise, and his industry progresses with him. Are we doing all we should and all we might do on this side to keep pace with this progressive movement? We fear not, and yet such social advance leaves an indelible mark on its generation, and expresses itself industrially in good merchandise and low prices."

This note of warning sounded by the *Globe* is more in accordance with common sense and a proper regard for national interests than the stubborn assertions and British selfishness apparent in the general press effusions of our friends across the sea. We would remind Englishmen that when it is a matter of machinery and machine tools this country stands without a rival; a visit to their own national workshops at Woolwich and Enfield, will prove to them that the finest tools therein bear the American trademark, that the same may be said of every other English workshop where national prejudice has not blinded the proprietor to his own private interest.

The *Globe* explains very clearly some of the reasons for this mechanical superiority in American machinery, and our neighbors might as well accept the situation without so much grumbling. In this matter of pumping-engines especially, we excel the world; and we particularly excel the massive and clumsy cast-iron combinations of antique design still made and used for pumping water in England. English machinery is somewhat like the Englishman himself, substantial, strong, but rough and clumsy, and adhering stubbornly to the ideas of earlier days: we miss the grace of form, the sacrifice of all superfluous material, the efficient and carefully studied combination of parts to the purpose in hand, and the perfect finish that characterizes the machinery of this country. Our mechanical engineers are never content with the old, but are continually striving to improve upon past methods; just as the late head of this very firm that is now causing all this commotion in England, inaugurated and entirely new departure in pumping-engines, and conceived the form which has culminated in the high-pressure engines that now go from new America to do duty in ancient Egypt.

FRENCH engineers, among whom are Commandant Landas and M. Baronnet, are to begin further surveys in relation to the proposed African inland sea. Early in 1883, M. de Lesseps made a trip from the Bay of Gabes along the Oued Mellah to the Chotts, and came back fully convinced that it was practicable to make a canal from the estuary of the river Mellah to the great marsh lakes of Southern Tunis. The presen expedition will make additional studies on the spo with the two-fold view of constructing a harbor at th mouth of the Oued Mellah, and of ascertaining th feasibility of sinking artesian wells along the pro posed line of the canal and the best route for a service railway.

Geological Survey of New Jersey.

We are in receipt of a set of the new contour maps of the State of New Jersey; six in number and including, No. 2, South-western Highlands; No. 8, Central Highlands; No. 4. North-eastern Highlands; No. 6, Central Red Sandstone: No. 7, North-eastern Red Sandstone, and No. 16, Egg Harbor. Sheet No. 6 includes the vicinity of New York and almost the entire Ramapo water-shed.

These State maps are well worthy of attention as being the first attempt in this country of an *accurate* contouring survey on an extended scale. Each sheet is uniform in size and in scale of map, the latter being one mile to the inch. The contours are carried over the entire surface and the lines indicate differences of level of 20 feet in the hilly portions and 10 feet in the flatter country. All railways, roads, streams and towns are located, and in addition to these are noted the various mines, quarries, clay pits etc.

The draftsman's work upon these maps is simply exquisite, unsurpassed by anything brought to our notice, not even excepting the maps of the U. S. Coast Survey. The value of these maps is incalculable to the engineer, and the appreciation of their local value which has authorized them and the skill and patient labor which has produced them can not be too highly commended.

The survey was inaugurated by the State of New Jersey in 1877 and proscecuted by it until July, 1884, when the completion of the half of the work remaining to be done was undertaken by the U. S. Geological Survey. The organization and working methods of the survey were left exactly as before, only the means were provided by the U. S. G. S. The work will be completed in New Jersey by July, 1887, at the present rate of progress and both the State and the United States will then be in possession of duplicated original sheets on a scale of 3 inches to the mile. As mentioned before, the scale for State publication will be one mile to the inch; for the U. S. Geological Survey the scale will be 1 to 62,500.

A New Water Supply for Moscow, Russia.

The Mayor of Moscow forwards us an invitation for proposals for the construction and working of a water-works in that city. While the date, "April 2-14," is somewhat too close to permit any active competition from American builders, the substance of the proposed contract may be of interest.

The quantity of water first demanded is 3½ million *vedros* (9,450,000 gallons); and this must be delivered in such manner that half of this quantity shall be supplied to the district mains in the six hours of greatest demand, the remainder in the next 18 hours. The mains first laid shall be in length not less than 260 *versts* (910,000 feet); and they must be proportioned for an ultimate supply of 27 million gallons per day.

The daily consumption is figured at 5 *vegros* (13½ gallons) for each *sagene* (7 feet) of main, in fixing up on the laying of new mains in unsupplied streets. The water is to be subsoil spring water from the neighborhood of Mitischi; and the arrangement for collecting and conveying must be such that no surface water from ponds, lakes or rivers can leak in. The works must be direct acting and arrangements made to increase the pressure in case of fire. The constant pressure must be capable of forcing water 70 feet above the surface; the fire-pressure must equal "4 atmospheres" at the hydrant. Each hydrant must be capable of supplying 50 vedros (135 gallons) per minute. The pressure in the mains must nowhere exceed 7 atmospheres.

The works must be opened in four years, and the concession is granted to the constructors for 50 years. The conditions of the concessions are, that from the day of opening, the works built by the contractor become the property of the city, but remain in the hands of the contractor, to be worked by him for his profit during the term of years named on conditions embodied in the contract and confirmed by the *Douma*. All rights can be purchased of the city, at any time, on conditions laid down in the contract.

The contractor cannot charge consumers more than 12 *coppecks* for 100 *vedros* ($9\frac{1}{100}$ cts. per 270 gallons), when the total daily supply does not exceed 11 million gallons; 11 *coppecks* ($8\frac{17}{100}$ cts.) with a daily supply of from 11 to 16 millions of gallons; 10 *coppecks* ($7\frac{1}{10}$ cts.) for a supply of from 16 to 21 millions; and 9 *coppecks* ($7\frac{33}{100}$ cts.) when the supply is from 21 to 24 millions daily.

When the profits amount to 8% on the total capital invested by the contractor, all excess over this 8% is to be equally divided between the contractor and the city.

At every 3 *versts* (10,500 feet) in length of the mains a water supply place must be fixed, with a cock supplying 4 gallons per minute, for gratuitous distribution of water to every body who takes water in hand utensils. The contractor must furnish water for town buildings, fountains, for flushing sewers, etc., to an amount not to exceed 20% of the total supply, for one half current rates.

The contractor must deposit 300,000 roubles ($231,000) with the town council at time of making tender as a security for fulfillment. The contractor will be fined for all irregularities, such as, non-working of hydrants, non-supply of water at any one of the public water supply places during 24 hours, impurity of water supply for 24 hours, and impurity of water in any house through fault of contractor. The fines range from 500 roubles, for the first offence, to 3,000 rubles, for the fifth (a rouble is 77 cts.) Persistence in wrong-doing will make the contractor liable to the forfeiture of his concession. At the expiration of the concession the entire plant passes free of charge to the town.

Bidders are requested to send in proposals before 1 o'clock P. M. of "April 2-14" 1885, directed to the Town Council of Moscow, and at the same time deposit the guarantee of 300,000 roubles. Preference will be given to those who propose to construct the plant in Russia and with Russian material and this must be stated in proposal.

A New Explosive, Called Green Powder.

Le Credit Minier calls attention to the preparation and properties of a newly invented explosive, called *poudre verte*.

This new powder is composed of three elements in proportions as follows: Chlorate of potash, 14 grammes; picric acid, 4 grammes; yellow prussiate of potash, 3 grammes. These elements are finely pulverized after being first well dried in a stove at 100° C, or upon an iron plate. This done they are mixed in the proper proportions. While this powder resists shock pretty well, the mixing should be effected without friction. This can easily be done by putting it into a glass vessel, or, better still, into a wooden cask, with a few wooden balls and then rotating the vessel. The wooden balls will crush the lumps of chlorate of potash which have a constant tendency to thus arrange themselves isolated from the rest of the ingredients.

This powder is a good breaking agent and in violence is comparable to dynamite. The cost of production is less than that of dynamite and its manufacture is easy. With the three substances pulverized in advance, a mixture upon a plate, a newspaper, or even upon a handkerchief, is all that is required to obtain an efficient explosive.

It is attacked by dampness; and while yellow in color at the time of preparation, it becomes a beautiful green at the end of a few days.

Experiments made in quarry-work prove that this powder should be compressed so as to obtain the full value of its rending power. When solidly compressed in paper cartridges, it is perfectly preserved, and undergoes a chemical or molecular modification which increases its explosive power. It is well adapted for the uses of the pyrotechnist.

PERSONAL.

HENRY M. WIGHTMAN, City Engineer of Boston, is seriously ill with pnemonia, contracted on his way home from North Carolina a few days ago.

MR. GEO. H. FROST of this journal will sail on the Inman Steamer *City of Chicago* on the 9th for a business trip to Edinburgh, London and Paris.

SECRETARY MANNING appointed S. E. MAXON Superintendent of construction of the new public building at Council Bluffs, Iowa, vice O. J. King, resigned.

MR. WILLIAM H. WILEY of the firm of Jno. Wiley & Sons, Publishers, and American Agents of London *Engineering*, will sail on the Inman Steamer *City of Chicago* on the 9th for a business trip to Edinburgh, London and Paris.

MR. T. H. BOORMAN, long connected with the Asphalt and Cement trade in this city, has associated himself with MR. MATT TAYLOR for the purpose of carrying on the Asphalt business in all its branches. This is a combination of "good fellows" and alert business men, to which this journal personally wishes every success.

GEORGE S. MORISON, the well-known railway expert and bridge builder, has not only built some of the largest and best iron bridges in the country, under the most difficult circumstances as to site, but he has done what is a rare thing for American engineers to do—given the most careful and complete records of his most important bridges to the public in the form of reports to the railway companies for whom he was the engineer. His most notable reports are those of the Plattsmouth and Bismarck Bridges, which are in themselves treatises on large iron railway bridges of most excellent recent construction. MR. MORISON has set an example which should be largely imitated by his brother engineers of equal eminence.

Boston Society of Civil Engineers.

The annual meeting of the Boston Society of Civil Engineers was held at Young's Hotel on Wednesday March 18th; Vice President L. F. Rice in the chair and forty seven members present. The annual report of the Board of Government was presented, accepted and ordered to be printed.

Officers for the ensuing year elected as follows:

President: Geo. L. Vose; *Vice President*: L. F. Rice; *Secretary*: H L. Eaton; *Treasurer*: Henry Manley; *Libarian*: A. F. Noyes; *Auditor*: E. W. Howe.

A memorial of the late Samuel F. Johnson was presented by Thos. Doane.

It was announced that a collection of minerals had been presented to the Society by C. H. Haswell, and the government were requested to extend to Mr. Haswell the thanks of the society.

Mr. Chas. P. Putnam was elected a member of the Society.

The business meeting was followed by the annual dinner of the society which was participated in by members of the society and their guests to the number of fifty five. After

dinner remarks were made by H L Whiting, Henry Mitchell, of the Mississippi River Comm.; S. H. Scudder, Editor of *Science*; Major C. W. Raymond, Thos. Doane, A. Fteley, J. H. Shedd, and others.

Liverpool Engineering Society.

The usual fortnightly meeting of this society was held last evening, at the Royal Institution, Colquitt-street, Mr. W. E. Mills, President, in the chair. A paper by Mr. J. J. Webster, Assoc. M. Inst. C. E., entitled "Notes on Constructional Ironwork," was read by the author. After referring to the enormous amount of ironwork used annually in the construction of warehouses and offices, as giving ample opportunities for studying the different modes of construction, he discussed the joints in connection with various forms of beams, and especially of the rolled girder type—showed the errors of design occasionally committed, and that the tables of safe loads given on published sheets of section were not to be relied upon, and that in all cases the safe load should be calculated in each particular case as a check. He then went into the investigation of the strength of such beams, and showed how they could be calculated. The question of independent and continuous girders was then considered, and he showed how in many cases girders were designed and constructed as independent girders, yet from the nature of their position in the building and the application of the load they were actually acting as continuous girders, and should therefore have been designed as such. He next considered the different forms of joints and covers, and afterwards went into the investigation of columns, showing the correct form and the correct material to be used under different conditions; and, lastly, he considered the question of testing the different materials. The paper was illustrated with numerous diagrams.—*Liverpool "Daily Post," March* 12, 1885.

Novel Application of the Diving Dress.

In the important coal-mining district of Polnisch-Ostrau, in Austria, a destructive colliery explosion took place last June, the result being that one of the pits caught fire and has been burning ever since. It was impossible to resort to the extreme measure of putting out this conflagration by sinking the pit under water, as that would have meant flooding the deeper pits in the vicinity and ruining the whole district. In this dilemma the engineer in charge determined to obtain a number of diving dresses, with the help of which workmen descending into the deadly atmosphere of the mine could be readily supplied with fresh air from the surface, and could perform the task of bricking up the burning galleries in safety. The fire had assumed such large dimensions within a few hours after breaking out that, in hurriedly erecting the walls to cut off the Wilhelm pit from two of the nearest pits, an engineer and two workmen lost their lives. The diving dresses having been obtained from Bremen, several workmen put them on and were let down the Wilhelm shaft with the requisite building materials, and began the work of isolating the burning portions of the mine by building strong walls of cemented masonry. The operations, which were not performed without great difficulty, had to be carried on for several months, but were at length completed with safety, and with such success that a few days ago the miners were able to resume work in the still burning mine. Herr Mayer, to whom the credit of this promising innovation in the use of the diving apparatus is due, holds the office of chief engineer to the Austrian Northwestern Railway Company, who are proprietors of the collieries at Polnisch-Ostrau.

CORRESPONDENCE.

Freezing of Water Mains.

VANDERBILT UNIVERSITY, NASHVILLE, TENN., March, 25, 1885.

EDITOR ENGINEERING NEWS: Regarding the request of Mr. Fayette Marsh for information as to the cause of water pipes freezing in St. Paul, Minneapolis, and Duluth, not during winter but after the mild weather of spring had come, I write to say that the cause is doubtless that the soil at the depth of the pipes—seven or eight feet—having become warmed by the heat of the previous summer, retains sufficient heat to prevent freezing during the winter and until, by the slow conduction of heat upward, the temperature is reduced to freezing.

In other words, the "*cold wave*"—if we might use such a term—requires several weeks to penetrate to the depth in question.

The subject of underground temperatures has been studied for years at Greenwich, and at Edinburg.

At the latter place, the conductivity of the soil is such that thermometers sunk 16 feet in the earth, reached their maxima and minima, about six months after the corresponding maxima and minima of the surface, being coldest during July. Similar experiments made by me while a student at the Union College Engineering School, Schenectady, N. Y., showed, for that particular soil, an average velocity of heat transmission—upwards 3.4 feet per month—downwards 2.9 feet per month.

OLIN H. LANDRETH.

NOTE:—C. W. S. Seymour, Supt. of the Hingham, Mass., Water-works, also sends us an explanation similar to those already published.—ED. ENG. NEWS.

Ground Water at Suakim.

NEW YORK, April 2, 1885.

EDITOR ENGINEERING NEWS:—The puzzle presented by the existance of wells in a rainless country, notably in the desert of the Soudan, is not satisfactorily solved by your correspondent in his communication on page 204 of your journal, although being in the country, and in search of water, it might be supposed that his experience would settle the question, but it would appear, that if anything, he has rather added to the puzzle.

He says that wells having been dug at Massawah from ¾ to 2 miles from the shore of the Red Sea, he determined their levels and "found that the depth of the wells exactly equal to the elevation of the surface above sea level, and concluded that the water of the wells was nothing more than the filtered waters of the Red Sea, and therefore inexhaustable in quantity;" he found it a little brackish, "but learned to like it." He adds, "If this were the case at Massawah why should it not be so at Suakim, and uses this as an argument to repeat Col. Prout's statement, "that from Suakim to Berber, the pipe line if laid must be supplied from the Nile."

We beg leave to interpose some objections to the views of your correspondent.

In the first place Massawah is some 300 miles south of Suakim, and just that distance nearer the high lands of Abyssinia, which is the water-shed, the drainage from which furnishes the high Nile with its flood water by way of the Blue Nile at times of inundation. Some of the affluents of the Atbara River (if that may be called a river which at times is absolutely dry), head up in the high land, south and west of Massawah. The high range in this neighborhood (one peak being over 7000 feet high) is the source also of mountain torrents, which when full, have all the characteristics of rivers, but without outlet of any kind, losing themselves in the sands of the desert west of Massawah, and north of Kassala, long distances from their source. The rains in this high region, unlike that in the neighborhood of, and to the west of Suakim, are most decidedly periodical, and may be counted upon with certainty in the months of July, August and September, and at such times, the lost rivers, do undoubtedly supply a ground water, the character of the surface forming this idea; but to what extent north into Nubia, the widely extended deserts are supplied with ground water through formally dispersed channels, it is impossible to say at present, but the eastern slopes of this range, while narrow as compared with the western, is still extensive enough to yield from the tropical rains a large body of ground water, which would be found by sinking wells near the sea. The water in the wells observed by your correspondent, within two miles of the sea shore, was unquestionably this ground water, and not the water from the Red Sea, for he says, the level of the wells 'was precisely that of the sea," which it could not have been if derived from the latter, as he overlooks the fact that there would be a loss of head in passing through the sand—on Long Island the head required would be from 8 to 10 feet per mile! Hence this water could not have come from the sea—and further; if from the sea, no amount of filtration merely through sand, would perceptably diminish its saltness, or render it potable, the saline principle in sea water being in solution and not in suspension; and the examples he furnishes of the experience on our Southern Coast, as tending to confirm his sea water hypothesis, are in reality directly in opposition to it, as it is well known that the fresh water found upon excavation near our coast line in many localities, is derived from the ground water of the back country, seeking the tide level, (see Nichols on water supply); and we may safely affirm, that if the British troops are compelled to resort to sea water freshened simply by filtration through sand, the time of their stay in the country could be readily determined, and an effective means of settling the Soudan difficulty reached.

J. W. A.

Extensive Topographical Surveys.

NEW BRUNSWICK, N. J., March 31.

EDITOR ENGINEERING NEWS.—In your last issue I noticed that, in a paper on topographical surveying, reference was made to a survey in Pennsylvania, covering some 500 square miles, as being the most extensive that has been undertaken in this country. To save other members of the profession from similar statements, and as a matter of general interest, I publish a few statistics of work done in New Jersey in prosecuting the detailed topographical survey, with contours, which was inaugurated by the State in 1877 and has since been steadily prosecuted under the direction of the State Geologist.

At the close of 1884 the area surveyed and contoured, with 10 feet vertical intervals in the level country and 20 feet in the hilly portions, had reached 4,438 square miles. In addition to the 250, or more geographical positions determined by the U. S. Coast and Geodetic survey about 50 subsidiary points have been determined by the topographer by triangulation. About 12,000 miles of lines have been leveled with the Y level. Over 450 miles of line have been measured with transit and stadia and 10,000 miles of roads have been run with odometer and compass.

The elevation of surface have been determined almost entirely with the engineer's leveling instrument, the Abney level having been used but sparingly although it is an excellent instrument for reconnoissance. A very limited use has also been made of the Aneroid. Instead of the Pratt range finder a simple attachment to the leveling instrument, which utilizes the pointing powers of the telescope, and gives results superior to the Pratt instrument, has been adopted for ascertaining distances below half a mile; the time required to determine such distance not exceeding two minutes.

The amount of transit work done has been proportionally less than on the survey above referred to; the object having been to distribute the work done as uniformly as possible over the area to be surveyed, no such methods as triangulation with Azimuth Compass having been resorted to.

Although the United States Geological Survey assumed the expense of completing the half of the work remaining to be done on the 16th of July, 1884, and is now vigorously prosecuting the work to completion, yet the honor of inaugurating a topographical survey suited the advanced requirements of the country, and of successfully prosecuting it over an extended area undoubtedly belongs to New Jersey, and in a communication to the National Academy of Sciences, October meeting, Director J. W. Powell of the United States Geological Survey finds that the only topographical work done by the States which will be suitable for a map of the United States, such as is needed by his survey, is the work in New Jersey and a limited amount of work in Wisconsin.

At a time when scientific men are complaining so loudly of the lack of appreciation of such work by the legislators of the States, and not always justly, it is worthy of note when a Legislature does sustain and encourage such work and consistency demand, that proper credit shall be accorded to such enterprise.

TOPOGRAPHER.

THE maximum speed of passenger trains in England is a trifle over seventy kilometers (a kilometer is almost exactly five-eights of a mile) per hour, and this maximum is only attained by the train running between London and Edinburgh. In France the maximum is a trifle over sixty-three kilometers an hour (on the rapid train between Paris and Bordeaux). In Germany it is sixty-three kilometers an hour, and in the United States sixty-seven kilometers an hour.

A NEW ASTRONOMER.—A citizen of Pipesville, O. writes to a New York paper of a discovery he made in regard to the distance the sun is from the earth. The gentleman is evidently sincere. He says "I measure the same way that we measure the height of a tree while standing, and being about 3,000 miles north of the equator, by taking a spirit-level and a carpenter's square, I find the distance to the sun is just 3,000 miles from the equator, or, in other words, 3,000 miles from the earth. I also claim the earth is stationary, and the North pole is the center, and the sun, moon and stars travel around it. By my measure the sun is 100 miles across the face."

For Measuring Time.

The first people who appear to have divided the day into portions were the Assyrians, who invented the clepsydra, or water clock, at a period too remote for precise calculation. All that is known for certain is that the apparatus existed before the overthrow of the first Assyrian empire by Abaces and Beleses, in the year 759 B. C.

This water clock was nothing more than a brass vessel of cylindrical shape holding several gallons of water. A very small hole was bored in one of its sides, through which the liquid was allowed to trickle, and it was calculated that the vessel could empty itself about five or six times a day. Under the reign of Phul, the royal palace of Nineveh, and each of the principal districts of the city possessed a water clock of the same shape and capacity. They were all filled together or as nearly as possible together, at the signal of a watchman stationed aloft on a tower to proclaim the rising of the sun, and they remained all day in the keeping of officials, whose business it was to fill them as soon as they became empty. There was a regular staff of criers employed in connection with each of the time offices, and as often as the water clocks were replenished they passed through the streets shouting out the fact for the benefit of the townspeople. In this way a sort of rough computation of the flight of time was obtained. The intervals between the filling and emptying of these vessels were called "watches," and were of about two hours and a half's duration. It is hard to suppose that the water clocks kept very steady pace with each other. The difficulty of making by hand vessels of the same size, of drilling them with holes precisely the same diameter and of supplying them with water of just the same density must have given rise to a great deal of irregularity in the working of these machines.

The clepsydra remained in its primitive condition for many centuries, and it was not until the invention of the Sun Dial at Alexandria, 580 years before Christ, that it underwent any improvement. About that time an Egyptian of Memphis added a dial, with a hand, to the clepsydra. The hand revolved on a pivot, and communicated with a string which was fastened to a float. As the water leaked out the float fell with it, and the tension of the string caused the hand to move around with spasmodic jerks.

This reform, though meritorious in theory, proved deficient in practice, for the old difficulty about getting the clocks to keep step was doubled or trebled when the system became complicated with dial, needle, string and float. But notwithstanding its drawbacks, the improvement was a valuable one, because it prepared the way for further changes and led to the perfection of the water clock by the substitution of a system of dented wheels for those already in use. The wheels were set to work on the water mill principle, and the addition of a second needle allowed the clock to mark the fractions of the different "watches."

This was the *ne plus ultra* so far as the clepsydra was concerned. It dates from 250 years before Christ, and Egypt, which had become the great mart of the new time-piece, exported them to the different countries of the East as rare curiosities and at fabulous prices. When Pompey returned to Rome, in the year 62 before Christ, after triumphing over Antiochus and Mithridates, one of the most valuable trophies he brought with him from the treasures of the King of Pontus was an Egyptian clepsydra, marking the hours and minutes according to the method of horology in use in Rome.

The cylinder which served as a receptacle for the water was of gold, as was also the dial plate. The hands were studded with small rubies, and each of the ciphers that denoted the twenty-four hours of the day was cut out of a sapphire. The cylinder only needed replenishing once a day.

Then came the age of total darkness that followed the overthrow of the Roman empire. The barbarians who conquered the imperial city had very primitive modes of marking the course of time.

At the break of day, when the chieftain of the camp or village rose, a boy slave came and took his position at the entrance of the hut and sat there with two helmets, one full of pebbles and the other empty before him. His business was to transfer the pebbles, one by one, from the first helmet to the second, and not too fast, after which he surrendered the position to some one else, who repeated the operation, and so on until it became dusk. As the helmets were large and the pebbles small, it took a good two hours to make the transfer.

As soon as the helmet had been emptied, the fact was proclaimed through the camp by the striking of a sword against a shield, gong fashion, at the chieftain's door. The echo was caught up and all around the people knew that their dinner time had come.

The methods of marking time differed according to the locality. In peasant districts, the laborer reckoned by the number of furrows he could plough, or, if it was harvest time, by the quantity of corn he could reap. In towns where some faint remnant of Roman civilization survived, the reckoning was kept by watchmen. At daybreak a soldier started on foot, or, if the town was a large one, on horseback, to walk around the city. When he had gone his round the first watch was over, and he returned to his quarters blowing loudly on a trumpet, when a second soldier set out in silence to perform the second watch. This continued uninterruptedly day and night, the only difference being that after sunset there was no trumpet blowing, and the watchmen, instead of going round singly, went their rounds in batches of ten or a dozen.

As a last instance of barbarous chronometry, allusion should be made to the method employed in monasteries. The monks were in the habit of computing time by the number of prayers they could say, and it was from this that the custom of wearing chaplets of beads arose. The task assigned to each monk was to recite as many "paters" and "aves" as there was beads on his string, and, as the number on a chaplet was supposed to be then thirty-three, that is, one for each year of our Saviour's life, there was work for a good hour and a half if conscientiously performed. As in the case of the urban watchman, one monk was relieved by another, and the termination of each "vigil" was notified to the community by the tolling of the chapel bell. This custom continues unaltered in certain monastic establishments. In monasteries of a severe order there is no such thing as a clock. The only timekeepers are the shorn, becowled monks kneeling in perpetual adoration.

It was the famous caliph of Bagdad, Haroun-al-Raschid, who restored the old water clock to Europe. In the year 807, he sent a very beautiful clepsydra to Charlemagne, but it was looked upon as a thing to be admired and not to be copied after.

The reason of this was that the sablier or sandglass, had been invented in France shortly before the accession of Charlemagne, and the contrivance was considered handier and more simple than the other.

The first sablier was invented by the man who reinvented the blowing of glass after the secret had been lost for years. He was a monk of Chartres named Luitprand, and the sand glass he made was the exact prototype of all those that have been made since. It consisted of two pear shaped receptacles joined by their slender ends. When the sand had all run from one end to the other, the lower glass was turned uppermost and kept in that position until empty. Charlemagne caused a monster sablier to be made with the horal divisions marked on the outside by thin lines of red paint. This was the first hour glass. It required to be turned over only once in twelve hours, and it kept time with as much precision as the best of our lever clocks. Many persons still consider the hour glass the best time keeper ever invented. King Alfred devised a method of computing time by means of a rush light set in a lantern.

Anything more unsatisfactorily or expensive than this it was impossible to imagine. One might very well flicker for an hour and another flame away in ten minutes.

The first real clock was set up in 1734, during the reign of Charles V of France. The maker was one Henri de Vic, an Arab, who had been converted to Christianity. The clock was a monster machine, weighing 500 weight. It was put up in the round tower of the royal palace, now the Palais de Justice, and attracted crowds for several months after it was erected. The maker received a pension of 100 crowns of gold for life and was ennobled. He is the first artificer on whom this distinction was ever conferred in France. From this time the making of large clocks for public edifices was extensively carried on throughout Europe.

But it was not until the beginning of the sixteenth century that small clocks were made for apartments. The first one came from Florence in 1518 as a present from Julio de Medici to King Francis I of France.

The invention of watches had preceded by a few years that of small clocks. Popular tradition ascribes the invention of watches to Peter Hele of Nuremberg in the year 1490; but King Robert of Scotland possessed one as far back as 1310. German watches were not introduced at the English court until 1597. They cost fabulous sums of money, and were made in fancy forms, such as acorns, olives, walnuts and crosses, and were also worn as pendants to ladies' bracelets. Claude, wife of Francis I of France, had one so small that it was set in a ring. Hugens of Zulichem invented the pendulum clock, the simplest and most admirable machine. The invention of the spring pocket watch is accorded to the Englishman Hooke in 1658, and eighteen years after this the first repeating watch was made at Amsterdam.

Since 1676 no new developments have been made in the mechanical science of horology. But in latter days Helesses and Hugensen have discovered several methods of making clocks go by electricity without giving us the great trouble of winding.

In the last century the watches of Geneva were unrivalled, but nowadays, from wishing to make too cheaply, Geneva has lost some of her prestige, and Swiss watches have come to be looked upon with some disfavor, especially in England. There seems to be a battle for supremacy between France and England. France carries off the palm for the exquisite beauty of ladies' watches, while England has great reputation for the soundness and finish of gentlemen's watches, and America, though younger in the art of horology, is not behind the other nations in the way of fame.

English chronometers are held incomparable the whole world over. All the naval chronometers undergo a probationary stage of six months, and often longer, at Greenwich observatory before they are ready to go over the seas. They are subjected to a whole series of scientific experiments, comprising all possible changes of temperature, ordeal by fire and ordeal by water. The work is very difficult, and when a man completes the examination he should rank as an artist, rather than a mere mechanic.—*Utica Press.*

Scientific Experts on the Continent.

J. LOWTHIAN BELL, F. R. S.

In most European countries, certainly in Sweden, Belgium, Austria, Germany, and France (which pretty nearly exhausts the iron-making countries of Europe), the means of education are far more widely spread than they are in this country, and I think that has given rise to a class of scientific men of which we have not so many examples in this country—men who seem to devote their minds almost exclusively to industrial science. Professor Tunner has devoted a long life to metallurgical research. Then there are Professor Akerman in Stockholm, Gruner in Paris, and many others in Belgium, Germany and elsewhere. In fact this kind of instruction has been looked on for many years, I may say almost for centuries, with more favor abroad than it has been here. Going back as much as three hundred years ago, you have a very distinguished man writing on metallurgy in Germany, Agricola, a work so old as to be written in Latin. Then coming down to our own time you had Karston, whom I met forty years ago in Berlin. All these men devoted a considerable part of their scientific career to the investigation of matters connected with practical industry. I do not say that there are not such cases to be met with in England but I think they are more frequently found abroad than they are with ourselves.

The Education of the Artisan.

PROFESSOR HUXLEY.

For myself, I look upon simple knowledge by itself as of far less importance to the artisan in his career in life than a number of other qualities. I do not say that knowledge is not an extremely good thing, but if a man is to make a good workman, or to do anything in practical life, you must give him an education which fits him for the conditions of life with which he has to deal, and you will not give him that education by filling his head with a number of intellectual abstractions, or even by giving him the largest acquaintance with scientific principles. And I think it is a profound mistake, considering the career to which the majority of artisans or persons in that class of life are necessarily bound, ever to take them out of the wholesale discipline of practical contact with the realities of life, for the mere sake of giving them a greater or less amount of knowledge. A man who is inclined to do so may always pick up knowledge, and he may do so at the same time that he is getting his education, in the highest sense of the word, out of his contact with the realities of his daily life; but if you make a bookworm of him, if you take him away from all that contact with reality and turn him back afterwards into it, he has lost touch of life. I speak with the greatest hesitation, because I have nothing to do with industrial pursuits; but I have had to do with mankind in many stations in life, and it seems to me that what is wanted in a foreman is a man of energy, punctuality, business habits, and power of dealing with men, all of which things are not to be got out of books or laboratory work. These qualifications are the most essential qualifications in a foreman, and what you want besides in such a man is not book learning, but an intelligence sufficiently trained to be able to deal with new conditions, and an amount of knowledge sufficient to enable him to know where to go to find more if he wants it.

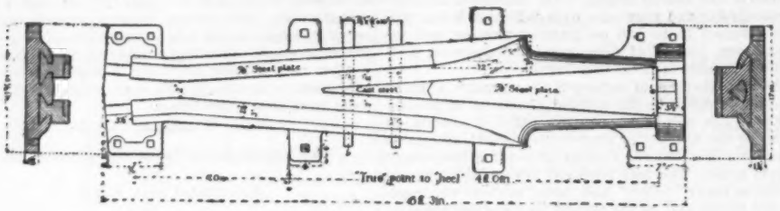

FIG. 74. CAST IRON FROG.

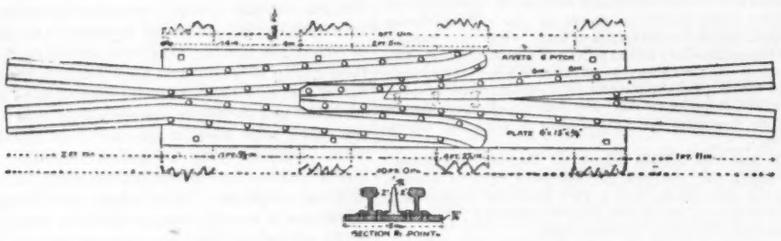

FIG. 75. PLATE OR RIVETED FROG.

TRACK.*

BY W. B. PARSONS, JR., C. E.
ROADMASTER SUSQUEHANNA DIVISION ERIE R. R.

(*Continued from page 203*).

The earliest and simplest form of frog was a pivoted or hinged rail but the oldest style properly so-called is the cast-iron frog, Fig. 74, at present found only on the older roads and fast dying out.

At first the whole frog was of cast-iron, but later while the main portion was of that material the wings where subject to wear and the rear portion of the tongue was covered with a steel plate ⅜ to 1 inch in thickness, while the "point," for such it was called, was made of cast steel, fitted into the recess of the casting and held there by two taper keys. The heel of this solid steel "point" was dovetailed to fit the main casting. The rails joining the frog were connected to it by being held in recesses or lugs at the ends. The size of the casting was arbitrary, but on account of the weight was made no longer than necessary and the general practice was about 6 feet long for a No. 8, which then would weigh in the neighborhood of 800 pounds. These frogs were made before the custom of numbering, and were designated by letters *A A, A, B, C,* whose angles are respectively 5° 15′, 7° 10′, 8° 30′ and 9° 45′, so that they correspond approximately to frog numbers 11, 8 (exactly), 6½ and 6. In addition to its weight there are many decided objections to this form of frog. Since the rails fitted into recesses, in itself a highly objectionable and loose contrivance, the frog had to be let into the ties in order to bring the bottom of these recesses down to the level of the base of the rail. The nature of the material made the frog necessarily rigid and unyielding, consequently unpleasant to ride over, which qualities soon resulted, especially in cold weather when the ground is frozen hard, in its own destruction. The ties supporting such a frog should be 8 inches thick and 10 inches face and placed under the projections intended for the spikes. To provide elasticity the Mansfield and other similar frogs were designed by introducing rubber as a cushion, but the successful production of steel rails opened an entirely new field in the manufacture of frogs. At present frogs, which are always made of steel rail held together by a variety of devices, may be divided into two classes; "stiff" in which the tongue and wings are rigidly connected; and "spring" where the parts are movable and controlled by a spring. These two classes are again subdivided into three each, "plate," "bolted," and "keyed," according to the mode of fastening. Fig. 75 shows a stiff plate frog where the rails are firmly riveted to an iron plate. In describing this frog in detail there are several items which obviously apply to all frogs exclusive of pattern, hence, they will not be repeated each time. The rails which form the tongue should be dovetailed together as shown in the figure to the extent of ¾-inch at least.

Each rail is placed to fit the other, and then they are securely riveted together by three rivets through the web. After which the sides of the head are planed down to form the point. Some manufacturers instead of dovetailing continue the sides of one rail straight and level the other rail off to fit against it, making a very weak joint. In order to strengthen the tongue at the point a piece of flat iron, 6 to 10 inches long, should be welded against the web between the head and base, old fish plates will answer. This should be done before planing so that the section of the point is V shaped as the cross sectional view indicates. Wing rails are bent into shape, and if it is necessary to do this or any other operation in frog manufacture by heat it should be done at as low temperature as possible, but heating should be avoided as it destroys temper. The foot of the point should be broad, therefore as much as possible of the rail bases should be left and the base of the wing rails cut away to receive it as shown. An entrant-angle like this should be obtuse or round as acuteness has a tendency to continue in the shape of a crack. The plate should be long enough to securely hold the parts, and in width contracted as much as possible in order to allow tamping bars to get under it. In thickness it should be stout so as not to bend and have sufficient material to allow the rivet holes on the under side to be counter-sunk; ¾-inch is found to answer best. To this plate the rails are riveted with ¾-inch rivets having about 6 inches pitch and the heads on the bottom counter-sunk.

(TO BE CONTINUED.)

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OF the $4,000,000 worth of general supplies purchased for the Canadian Pacific Railroad during 1884 only $100,000 worth, or about 2½ per cent. was bought outside of Canada. Including rails, which had to be imported, and all other expenditures in England and the United States, over 93 per cent. of the $22,000,000 or $23,000,000 which the company expended in 1884 was paid to the people of Canada.

ENGINEERING NEWS Three months for One Dollar.

The Theory and Calculation of Earthwork Slopes.*

Written for ENGINEERING NEWS.
BY MANSFIELD MERRIMAN, M. AM. SOC. C. E.
Prof of Civil Engineering at Lehigh University.

Continued from Page 199.

7. EQUILIBRIUM OF COHESIVE EARTH.—If the particles of earth be united by cohesion a slope may exist steeper than the angle of repose. Let Fig. 3 represent the practical case of an excavation *A B C* whose slope *A B* makes an angle Θ with the horizontal greater than the

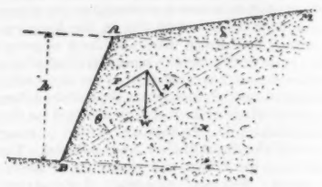

FIG. 3.

angle of repose φ. *A M* is the natural surface of the ground making an angle δ with the horizontal less than δ. It is required to determine the relation between the slope θ and the vertical depth h in order that rupture may first occur.

Let *B M* be the plane along which rupture occurs and x its inclination to the horizontal. The weight of the prism *B A M* tends to urge it down the plane and this is resisted by the forces of friction and cohesion acting in the plane. Let W be the weight of the prism for a length unity, and P and N its components parallel and normal to the plane. P is the force causing the downward sliding, $f N$ is the resisting force of friction, and $c l$ that of cohesion, if l be the area, or length of *B M*. At the moment of rupture $P = f N + c l$ which may be written

$$\frac{P - f N}{l} = c \qquad (8)$$

Now as x varies the forces P and N vary and for any other plane except that of rupture $\frac{P - f N}{l}$ is less than c. Hence the condition which will determine the value of x is

$$\frac{P - f N}{l} = \text{a maximum} \qquad (9)$$

When x has been found from (9) its value is to be inserted in (8) and thus the relation between θ and h be established.

To do this insert in (9) for P and N their values $W \sin x$ and $W \cos x$, and for f its value $\tan \delta$. Then it becomes

$$\frac{W \sin (x - \delta)}{l \cos \delta} = \text{a maximum} \qquad (9^1)$$

The value of W is the volume of the prism *B A M* multiplied by the weight of a unit of volume w, or

$$W = \tfrac{1}{2}\, B A .\, B M .\, w \sin (\theta - x) = \tfrac{1}{2} h l w \frac{\sin (\theta - x)}{\sin \theta}$$

and hence (9¹) becomes

$$\frac{h w \sin (\theta - x) \sin (x - \delta)}{2 \cos \delta \sin \theta} = \text{a maximum.}$$

This is a maximum with respect to x when

$$\theta - x = x - \delta \qquad (10)$$

that is, the plane of rupture bisects the angle between the lines of natural slope and excavated slope, or

$$x = \tfrac{1}{2} (\theta + \varphi) \qquad (10^1)$$

Now if (8) be expressed in terms of x it becomes

$$h w \sin (\Theta - x) \sin (x - \varphi) = 2 c \cos \delta \sin \Theta$$

and by virtue of (10¹) this reduces to

$$h w \sin 2\tfrac{1}{2} (\Theta - \Phi) = 2 c \cos \Phi \sin \Theta$$

*Copyright by ENGINEERING NEWS Publishing Company, 1885.

By substituting for $\sin 2\frac{1}{2}(\Theta-\Phi)$ its value $\frac{1}{2}(1-\cos\Theta-\Phi)$ and for c its value from (7) we have

$h(1-\cos(\Theta-\Phi) = H(1-\sin\Phi)\sin\Theta$ (11)

and this is the equation with scaps between h and Θ

This discussion shows that both the angle of rupture x and the relation between h and Θ are independent of the slope 8 made by the natural surface of the ground with the horizontal.

TO BE CONTINUED.

Programme of 5th Annual Meeting of the American Water Works Association.

TUESDAY, APRIL 21st, MORNING SESSION, 10 O'CLOCK A. M.

Opening exercises. Order of Business.

AFTERNOON SESSION, 2 O'CLOCK P. M.

Reading of Papers: "Water Waste:—its different phases," Peter Milne, Jr.; "Rules and Regulations," E. H. Brown; "Self closing Plumbing Work," W. C. Stripe; "Steam Boilers and their Settings," P. H. Linneen.

EVENING SESSION, 6.30 P. M.

Reception and dinner, tendered by the New England Water-Works Association.

WEDNESDAY APRIL 22nd. MORNING SESSION, 10 O'CLOCK A. M.

Order of Business.

RECEPTION OF REPORTS: *Pumping Engines*: John W. Hill, Wm B. Sherman, Wm. D. Hooker.

Kalamein Pipe: J. M. Carson, Frank Schefold, H. G. Holden.

Tests of Steam Coals: J. G. Briggs, Jno. W. Hill.

AFTERNOON SESSION.

Reading of papers: "What is Perfect Duty," Wm. Golden; "Difficulties encountered with Plumbers," W. L. Cameron; "Cast Iron Pipe," A. H. Howland; "Street Mains," Geo. A. Ellis.

EVENING SESSION, 8 O'CLOCK P.M.

Reading of papers: "Railroad Water Supply," B. F. Jones; "Annual Reports," J. J. R. Croes, Chas G. Price; "Rules Governing Duty Tests," A. G. Moore. Questions and Answers.

THURSDAY APRIL 23d., MORNING SESSION, 10 O'CLOCK A. M.

Regular Order of Business. Election of Officers. Adjournment.

Visit to Public Works of the City of Boston.

Note: Excursions to various points of interest, in and about the city, have been proposed, of which members may avail themselves.

Committee of Arrangements and Receptions { George A. Ellis, Edwin Darling, Desmond Fitzgerald, Equitable Water MeterCo. Chapman Valve Mfg. Co.

Coignet's Concrete.

BY CAPTAIN FOWKE.

M. Coignet, has, as a series of experiments, given us the recipes for making two kinds of concrete suitable for house building, which he distinguishes by the epithets of economic concrete and hard and solid concrete. The first is composed of sand, gravel, and pebbles, 7 parts; argillaceous earth, 3 parts; quicklime, 1 part. This concrete, he says, properly beaten up and mixed, has given walls nearly as hard as the common soft rubble masonry used in Paris. In price it competes with ordinary pisé work, over which, however, it has the advantage of being able to resist moisture. The hard concrete is composed of sand, gravel, and pebbles, 8 parts; common earth, burnt, and powdered, 1 part; cinders, powdered, 1 part; unslaked hydraulic lime, 1½ parts. The materials to be perfectly beaten up together. Their mixture gives a concrete which sets almost immediately, and becomes in a few days extremely hard and solid, which property may be still further increased by the addition of a small quantity, say one part, of cement, and the price, depending principally on that of the time and labor, was in Paris, under unfavorable circumstances, 3½*d.* to 4*d.* per cubic foot; with more favorable conditions, 2*d.* per cubic foot. A house three stories in height, 65 feet by 45 feet, standing on a terrace, having a perpendicular retaining wall 200 feet in length and 20 feet high, has been actually constructed with every part, including foundations, vaults of cellars, retaining wall, all walls, exterior and interior, without exception, of this hard concrete (Beton dur,) as well as the cornice, mouldings, string courses, balustrades, and parapets, and without bond iron, lintels, or wood throughout. The use of plaster in the interior is also avoided, as the concrete takes a surface sufficiently fine for papering.

Report to the German Cement-makers' Union.

On the Adulteration of Portland Cement*.

BY DRS. R. AND W. FRESENIUS, WIESBADEN.

Portland cement is now adulterated with substances of chemical composition almost identical with the cement itself, differing, however, in physical properties. The difficulties of detection have therefore greatly increased, as even a quantitative analysis does not always enable the analyst to judge with certainty whether a sample has been adulterated or not.

After many experiments, the following method has been devised. It is based on a comparison of some of the properties and behavior under certain conditions of genuine cement, and of substances used for its adulteration, such as finely ground slag and hydraulic lime. For instance—

a. Specific gravity.
b. Loss by ignition.
c. Behavior to water; that is, the alkalinity of the aqueous solution.
d. Behavior to diluted acid.
e. Behavior to chameleon solution.
f. Behavior to gaseous carbonic acid.

The specific gravity is determined in the apparatus and is based on an accurate determination of what space a given weight of the cement occupies.

In making a determination, the apparatus is first filled to the zero point with turpentine; 100 grams of the cement is then introduced, with the aid of a funnel, into the apparatus through the graduated tube. The cement at once falls to the bottom, and the liquid rises in the tube.

The number of cubic centimetres read off on the tube represents the volume occupied by the 100 grams of cement. By dividing the volume in cubic centimetres into the weight, the specific gravity is obtained.

Precautions necessary in Manipulating.—Keep the lower portion of the apparatus in water at air temperature, and control by thermometer, as constancy of temperature is very important. Give the apparatus a few gentle taps, in order to facilitate the escape of air-bubbles.

Close the tube with a cork until complete subsidence has taken place, in order to prevent evaporation of the liquid. The results of two experiments ought not to differ more than one unit in the second place of decimals.

The sample of cement in the above, and *for the following experiments*, should be so finely pulverized as all to pass through a sieve with 5,000 meshes to the square centimetre, = 32,257 meshes per square inch, or about 180 per lineal inch.

b. Loss by ignition is determined by heating 2 grams over an ordinary Bunsen lamp with chimney until the weight remains constant.

c. Behavior to water is determined by agitating 1 gram of finely-powdered cement with 100 cubic centimetres distilled water at ordinary temperature, for ten minutes after filtration; 50 cubic centimetres are titrated with 1.10 nitric acid.

d. Behavior to diluted acid is determined by agitating 1 gram of substance, finely pulverized, for ten minutes with a mixture of 30 cubic centimetres normal acid, and 70 cubic centimetres water. After filtration through a dry filter, 50 cubic centimetres are titrated back with normal soda solution, and from this the amount of normal acid neutralized by 1 gram substance, is calculated.

e. Behavior to Chameleon solution.—1 gram finely-pulverized substance, treated with 150 cubic centimetres of a mixture containing 1 part of H_2SO_4 (specific gravity 1.12,) and 2 parts of water. Chameleon solution is dropped into the liquid until it remains red for one minute.

f. Behavior to carbonic anhydride.—The experiment must be carried out as follows: 3 grams of the finely-pulverized substance is placed in a glass tube at ordinary temperature, and exposed to a stream of carbonic acid gas which has grievously passed through sulphuric acid. At further end of glass tube a chloride of calcium tube is fixed, in order to absorb any moisture that might be driven out by the carbonic acid.

*From Abstracts of Papers; Institution of Civil Engineers.

Description.	Specific Gravity.	Loss by Ignition.	Alkalinity of Aqueous Solution in N. A. corresponding to 0.5 gram Cement.	1 gram requires Normal Acid.	1 gram reduced Milligram.	3 grams absorb Milligram CO_2.
	a	*b* Per cent.	*c*	*d*	*e*	*f*
Portland cement, &c.	3.155	1.58	6.25	20.71	0.79	1.4

One may expect that a genuine Portland cement should possess a—

a. Specific gravity of at least 3.125; certainly not less than 3.1.

b. Loss by ignition between 0.34 and 2.59 per cent.

c. An alkalinity of the aqueous solution of 0.5 gram; substance should correspond to 4 to 6.25 cubic centimetres 1.10 normal acid.

d. The consumption of between 18.8 cubic centimetres and 21.67 cubic centimetres of normal acid, after treatment with 1 gram of cement.

e. The consumption of between 0.79 and 2.80 milligrams Chameleon solution by 1 gram cement.

f. An absorption of from 0 — 1.8 milligram C. 0.2 by 3 grams cement. Cements giving results which do not come within the limits given must be looked upon either with suspicion, or as beyond doubt adulterated, according to the results.

TABLE OF RESULTS OF EXPERIMENTS ON UNADULTERATED CEMENT.

Description and Composition of the mixture.	Specific Gravity.	Loss by Ignition.	Alkalinity of Aqueous Solution in N. A. corresponding to 0.5 gram Cement.	1 gram requires Cubic centimetre Normal Acid.	1 gram reduces Milligrams.	3 grams absorb Milligram CO_2.
	a	*b* Per cent.	*c*	*d*	*e*	*f*
1. One part hydraulic lime, nine parts Portland cement.	3.037	1.90	6.50	20.50		4.6
2. One part hydraulic lime, nine parts Portland cement	3.053	2.52	8.20	20.04	not determined	3.6
3. One part of slag neat nine parts of Portland cement.	3.114	2.04	3 8	19.53	6.11	2.6
4. One part of pulverized slag, nine parts of Portland cement.....	3.115	1.59	4.0	20.6	8.31	0.7
X.....	3.021	3.72	6.14	19.00	2.10	8.7
Y.....	3.048	0.55	4.55	17.20	36.40	1.2

The results under the headings *a*, *c*, *d*, and *e* apply to adulteration with slag.

Those under the headings *a*, *b*, *c* and *f* are of use in the detection of adulteration with hydraulic lime.

THE board of Public Works of Nashville, Tenn. have declared bids open for 4,000 tons of 36 inches cast-iron water pipe, which will be used for the force main of the new water-works system.

WATER.

SURVEYORS have been busy surveying the streets of Amesbury, Mass., and making a plan for a system of sewerage, which will be brought before the town at the adjourned meeting, April 13.

INCORPORATED.—Nevada Water Company, of Nevada; capital, $100,000; one half paid up. Incorporators—P. B. Perkins, Chas. Brooks and E. B. Loveland, all of Springfield, Mo.

THE City of Norfolk, Va., has contracted with the Holly Manufacturing Company for a Gaskill Pumping Engine and boilers, as a part of the plant for increasing the supply of water and the efficiency of the water-works.

THE Committee on Water Supply will give a hearing to parties interested in the petition of Josiah S. Kendall and others, a committee of the town of Belmont, Mass., for legislation to enable said town to supply itself and its inhabitants with water, and to construct suitable water-works, at Room No. 14 State House, Boston, on Friday, April 3, at 10 o'clock A. M.

IT is announced that the dam across the Mississipi at Brainerd, Minn., contemplated by the Mississippi Water Power & Boom Co., will be built during the coming summer, at the cost of $1,000,000. It seems that, under an old state law, the county commissioners are authorized to grant the privilage desired, where the state controls both sides of the stream, and the company will, therefore, go right ahead and not wait for legislation in congress.—Lake Superior *News*, March 28.

THE Brunswick, Ga., *Herald* wants the city government to own the gas works soon to be put in. The contract with the new company calls for an expenditure of $1,500 per annum for lighting a few of the principal streets. The *Herald* states that Richmond, Va., owns its gas works, and last year consumers were charged but 80 cents per 1,000 cubic feet, and yet so great was the income from the free use of gas even at this low price that it yielded the city government the respeceable sum of over $94,000 net profit.

AT a session of the Common Council of the city of Syracuse, N. Y., held on the 23rd, ult., the subject of an improved water supply was made the question of the evening and an ordinance was granted to the Central City Water Works Co., by the unanimous vote of the Council. It would be hard to find a dissenting voice among the citizens of Syracuse in regard to this grant. Hinds, Moffett & Co., of the city of Watertown are the official engineers of the company.

GAS PROFITS IN NEW YORK.—A summary of the testimony taken before the Gas Committee of the New York Senate shows that these companies are doing business on a capital of $47,000,000, and paying dividends on this, whereas the "legitimate" capital is about $20,000,000, showing that $27,000,000 is pure "water." The evidence is also said to show that if gas were furnished at $1 15 per 1,000 feet, the profit would still be 10 per cent., and that the consumers have already paid enough over and above the cost of production and 10 per cent. profit to duplicate the present system.

CHIEF Engineer Ludlow, of Philadelphia, reported to the Health Board that in nineteen wards there are 1478 properties whose occupants seem to reply wholly or in part upon other than city water for domestic uses, drawing their supply from 1036 pumps, thirteen wells and nine so-called springs, etc. Of these 1320 houses are upon streets in which city pipes have been laid, and 158 upon streets in which there are at present no city pipes. A noticeable feature of this exhibit is the very large percentage of premises relying upon the pumps on streets where public pipes are accessible. There is besides, a large number of families, in Summer especially, who resort to the pumps. Inspection by the Board of Health will doubtless develop the fact that, owing to their surroundings, most if not all of these wells are nuisances prejudicial to the public health.

NASHVILLE, March 26.—At the meeting of the City Council to-night J. C. Napier, the colored member, presided throughout the evening, the first time a colored man ever presided. The City Council finally passed a bill appropriating $450,000 for building and equipping new water-works, extending water mains and building new settling basins. The water will be filtered at an island in the river three miles above the city. The bill provides for the issuance of $450,000 water-works bonds under authority bestowed by act of 1882. The bonds should bear 6 per cent. interest, payable semi-annually, and should mature at the rate of $50,000 annually from April 30, 1907, to April 30, 1915. The bonds, it is stipulated, are to be a first mortgage upon the water-works and appurtenances, and to be redeemed, if necessary, by the net surplus of revenue derived therefrom.

Bill, appropriating $13,650 to lay 12 inch water main from the Square north on Market to Monroe, thence to the corporation line, was passed.

Bill, appropriating $17,500 to construct the Wilson Spring Branch sewer from the river to Summer street, passed third reading.

SOME Plainfield, Sullivan County, N. H., wells are frozen 15 feet below the surface.

NEW WATER MAIN.—The legislative committee on water has granted the request of Salem, Mass., to lay a new water main from the reservoir, through Beverly and across Bass river to North Salem, and issue water bonds to the amount of $150,000. Salem is willing that Beverly should have a separate main, provided that they pay their proportionate part of the expense that was entailed in raising the shores of the lake. Whatever Beverly may do, Salem must have a new main, as the old one is not to be depended upon, and its carrying capacity has been so much reduced by accretions to the inside of the pipes.

DANGERS FROM WATER.—The second of the series of lectures given under the auspices of the Hygiene Committee of the County Medical Society was delivered recently at the College of Physicians and Surgeons Thirteenth and Locust Streets, by Colonel William Ludlow, Chief Engineer of the Water Department, on "The Philadelphia Water Supply."

In his address he said: "Cholera, typhoid and like diseases are caused by water polluted with discharges from those afflicted with the diseases. In 1849 cholera killed 1,000 people in Philadelphia, and at the same rate would destroy 3,000 if the disease should fall upon the city the coming summer. The city's water is obtained from the Schuykill Valley, which receives the drainage from 350,000 people, and within the city limits, too, is subjected to the grossest dangers from the factories and dwellings of Manayunk. There are 1,200 wells along the water mains which are most foul sources of poison. The community itself is guilty for not stirring itself more in the matter. The reform must be made by those who have the knowledge, the means and opportunity. Philadelphia needs proper sanitation. There is no proper inspection of sewers or houses. There is no flushing of sewers. A city of the first rank is wallowing in the filth of fifty years ago.

The question was then formally discussed by members of the Board of Health and several physicians. Colonel Ludlow described in detail the proposed plan to obtain the city's water from the Delaware.—Philadelphia *Press*.

THE Board of Water Commissioners of Norfolk, Va., and the committee from the Councils met on the 25th ult., to consider the bids of contractors for laying the new 20" water main between Lakes Lawson and Bradford. The bids for the connection were as follows, distance 13,728 feet:

For laying alone—Adam Miller & Co., Rome, N. Y. 66 cents per foot; Sykes & Gwathmey, Norfolk, 67c.; John W. Rutterford, Hoboken, N. J., 68c.; A. J. Dalton, Norfolk, 75c.; Daniel Maloney, Norfolk, 76 cents; Leach & Baldwin, Philadelphia, 78c.; Hutchinson Bros., Baltimore, Md., 83c.; John B. Collins & Co., Norfolk, 86c.; Inman Bros., New York, 90c.; J. A. Donaghue & Co., Baltimore, Md., 95c.; W. R. Weaver & Co., Norfolk, $1.05; Virginius Freeman & Co., Norfolk, $1.15; Peed & Neville, Norfolk, $1.56.

Pipe alone—Warren Foundry, Phillipsburg, N. J., $27.90 per ton of 2,240 pounds; Camden Iron Works, Philadelphia, $23; Mellert Foundry, Reading, Pa., $28.50; A. H. McNeal, Burlington, N. J., $29; Cincinnati and Newport Company, Newport, Ky., $27.85 per ton of 2,000 pounds; Tredegar Iron Works, Richmond, Va., $28; Peed & Neville, Norfolk, $26 per ton of 1,912 pounds.

Pipe and laying complete—Camden Iron Works, Philadelphia, $36,791.04; Inman Bros., New York, $40,505.82; W. R. Weaver, Norfolk, $44,616; Peed & Neville, Norfolk, $51,215.

It will be seen that the lowest bid was made by the Camden Iron Works, and the contract was awarded to that concern. Work will begin at once, and under the terms of the contract must be completed by August 1.

THE city of Syracuse, N. Y., at a meeting of its Common Council held on the 23d ultimo, granted a franchise to the Central City Water-works Company, allowing them to lay down pipes and mains in the streets of said city, and agreeing to rent of said company 520 hydrants, and to pay $26,000 per annum for the use of same, for a term of twenty years. The Central City Water-works Company was organized by New York City and Watertown, N. Y., capitalists, with a capital stock of $2,000,000. They are to lay 40 miles of mains within three years, upon which the before mentioned 520 hydrants are to be located. The works are to have a capacity of furnishing 12,000,000 gallons of water daily, and the supply of water is to be taken from either Skaneatales or Oneida lake.

Mr. Frank B. Menville, of Albany is, the President of the company, and Messrs. Hinds, Moffet & Co., of Watertown, N. Y., are the engineers.

The water in either Skaneatales or Oneida lake is exceptionally pure and wholesome, and there can be no doubt but that under the direction of the very able engineers in charge of the work, Syracuse will soon rival Rochester in the excellence of its water-works system.

AMERICA WATERS HER DESERT.

All England is in an uproar and Parliament is in frantic excitement because the British government has bought some Yankee steam pumps for supplying water to the British army in the Soudan. "Buy where you can buy cheapest and best," the great English free trade watchword, is thrown to the winds; for "cheapest and best" means something outside of England. Not a single penny paid by a British tax-payer should be sent out of the country," say the English newspapers. They call the buying of the pumps "the American outrage," and scold the government for its "lack of business capacity" and its "grandmotherly managing," and say "British taxes are employed to enrich a rival nation while British artisans lack bread." In vain does the British government declare that American pumps are "cheapest and best," and that English pumps won't work satisfactorily, and that English pumps would have imperiled the whole expedition, and would have sacrificed a whole army of brave Englishmen. That makes no difference; the British people, both in the House of Commons and out, want a peremptory stop put to American pumping. Now we know how much their talk about "buying where you can buy cheapest and best" is worth. Meantime, the poor fellows in Soudan are going to have fountains, baths, rivers, gardens, lakes, all because of a few good American pumps.—STEPHEN HEWITT.

NEWS OF THE WEEK.

Miscellaneous.

Nearly 1,500 men are to be employed by the Pennsylvania Railroad next month, in addition to their present force, to straighten curves and repair the tracks between Philadelphia and Pittsburg. Surveys have been made and completed, and the rail distance between the two cities, while not materially decreased in point of actual length, will be cut down considerably in the facilities afforded trains to increase their running time.

Steel Rails.—Orders for 35,000 tons of steel rails were placed in Pennsylvania mills, the principal order being 20,000 tons for the Louisville and Nashville Railroad. Two thousand tons per month are to be delivered. The price is variously stated, but there is reason to believe that the net figure at the mill is low. It is certain that $26 has been shaded this week.

New Schoolhouse.—The Committee on Property of the Board of Education, Philadelphia, opened bids for the erection of a new schoolhouse in the Thirty-first Section, to be located at Sergeant and Emerald Streets. The contract was awarded to Thomas Cassidy, whose bid of $38,000 was the lowest. The other bidders were: Thomas Campbell, $43,390; William Thompson & Bro., $48,775; John O'Donnell, $44,075, Charles O'Neill, $44,900; and Franklin, $43,073. Contracts were also awarded for repairs on a number of schools in the various sections.

It is to be noted that the steel and iron manufacturers are doing better than any other class of industrial operators, and they are likely to do even better in the near future. It it generally thought that with the coming of good weather there will occur an activity in railroad building which will help business along.—Cleveland *Leader*.

Contracting.

Street Paving in Chicago.—The Commissioner estimates the total length of the proposed improvements at from thirty to forty miles. This does not include the alleys to be planked or otherwise improved or a considerable mileage of streets in the outlying districts that are to be curbed and filled to the grade line.

Bids for Dredging in the Mississippi.—Bids were opened on March 19, by Major A. Mackenzie, U. S. Engineers, for dredging in the Mississippi River. Five bids received, prices from 16¾ cents (accepted bid of Charles H. Appleton, of Quincy, Ill.) to 17, 20, 45 and 50 cents per cubic yard, the material to be deposited within 3 miles of dredging site.

Bids for Brush and Poles.—Bids were received on March 19, by Major A. Mackenzie, U. S. Engineers, for 6,000 cubic yards, brush and 6,000 poles, for use between St. Paul and Hastings, Minn. The brush bids ranged 34, 34½, 35½, and 75 cents per cubic yard; the pole bids, from 3, 3½, 4, and 25 cents per pole. The contract was divided between A. H. Truax and George Robinson, the aggregate being the same.

Bids for Dump and Flat Boats.—Major A. Mackenzie, U. S. Engineers, opened on March 19, bids for building 6 flat-boats, for use between St. Paul and Des Moines Rapids. The 14 bids ranged from $7,700 for the six (accepted bid of Thos. G. Isherwood of St. Claire, Ill.) to $37,200 for the six. The bids for the 6 dump-boats ranged from $8,340 (accepted bid of M. Von Hein, of St. Claire, Ill.) to $20,400 for the six boats.

Bids for 10,000 Cubic Yards Rip-rap.—Major A. Mackenzie, U. S. Engineers, opened proposals on March 19, at Rock Island for 10,000 cubic yards of rip-rap rock, delivered on the bank of the Mississippi, between Lansing and Dubuque, Iowa. The bids ranged from 79 cents, not delivered at point named, to $1.80 as specified. All bids were rejected as being higher than the open market price. Another set of ten bids were then received, ranging from 48¾ cents (accepted bid of Patterson Brothers, of Keokuk), to 59, 79, 65 and to $3.25

Insane Hospital at Knoxville.—The bill for the completion of the Insane Hospital at Knoxville, Tenn., appropriating $35,000 for the purpose, has passed the Legislature, March 27.

All Saint's Cathedral.—Contracts for the walls of All Saints' Cathedral, have been awarded to John Sneith, of Ithaca, N. Y., for $116,000. The contract calls for the erection of the walls of the Cathedral proper without the towers, the vestry, cloister, etc. The contract also includes the building of twenty-four memorial pillars in the nave. Money enough is now pledged to build the eastern half, which it is estimated will cost $50,000. The construction of the western half depends upon whether sufficient money to warrant the undertaking shall be raised. About $60,000 is now pledged. The work of the eastern half, if that alone is built, is to be finished by November 1. The walls are to be of Potsdam stone and brown stone.

East Carondelet.—The Prairie du Pont Drainage and Levee Commissioners met recently at the Village Hall to adjust the assessment of benefits and damages lands lying within the district. Justice J. W. McCormack presided, and a jury of twelve were sworn in to consider all complaints. The engineer, Paul Ilg, reported that the entire line of the proposed levee would extend a distance of 17,000 feet from the bluffs to the river, and thence to the Monroe county line, and that $13,000 would be necessary to build the levee to an 1845 grade. It was decided by the Commissioners that bonds to the above amount should be issued for the completion of the levee. The Commissioners are: Dr. Jacob Smizer, W. B. Quigley and Victor Sherman. There are 5,000 acres embraced within the district, which in 1882, 1883 and 1884 were overflowed, resulting in a loss nearly equaling the value of the land.—St. Louis *Globe Democrat*.

The following Contracts were awarded March 30th by the Public Improvement Committee, and City Engineer W. B. Knight, of Kansas City Mo. Grading Pacific street from Tracey avenue to east end of Pacific street 14,800 cubic yards of embankment to N. H. Comstock & Co., at 23¼ cents; Grading Fourth street from Broadway to Washington street 4,800 cubic yards excavation to James Crowley, at 21 cents per cubic yard; Grading Washington street from Fourth to Fifth street 4,600 cubic yards excavation to James Crowley at 21 cents per cubic yard; Grading Fifteenth street from Tracey avenue to Woodland avenue 9,000 cubic yards embankment to N. H. Comstock & Co., at 17¼ cents per cubic yard;—Constructing Section No. 4 of Sewer in District No. 108 was awarded to John Ryan of Denver, Colo., at the following prices: 540 feet of 2 feet brick sewer @ $2.77 per lineal foot; 2,835 feet 18" vitrified clay pipe sewer @ $1.58 per foot; 2,120 feet of 15 inch pipe @ $1.28; 3,235 feet of 12 inch pipe sewer @ $1.18; 2,175 feet of 10 inch pipe sewer at $1.12 per lineal foot, 27 receiving basins @ $80.00 each; 59 manholes @ $45.00 each; concrete @ $3.50 per cubic yard; lumber $20.00 per M.; rock excavation $4.00 per cubic yard. Total $20,846.

The other bidders were, John Shaw, $25,275; Robt. Chambers, $23,019; C. E. Donnelly, & Co., $22,505; Thos. Appleton, $26,040; Wm. Taylor, $23,415; J. D. Hackett, $28,473; W. H. Faulkner, $22,854; and Leo Felix $24,634.

Railroads, Bridges and Canals.

The Railroad Commission Wiped Out.—After four days of hard work and fillibustering the Tenn. Legislature repealed the railroad commission law by a vote of 56 to 35.

The Atchison, Topeka and Sante Fe Railroad Co.—has placed a survey corps in the field to run a branch railroad line from Bernalillo, forty miles south of Santa Fe, to the James Hot Springs, a distance of twenty-five miles.

Oregon Pacific R. R.—PORTLAND, Oregon, March 30.—It is reported to-night that Gould has purchased the Oregon Pacific Railroad, extending from Carvallis to Yaquima Bay, a distance of 70 miles. His object, it is said, is to extend the Oregon Short Line to the Pacific.

Lake Shore R. R.—President Newell is protesting against the completion of the South Pennsylvania Railroad, as the contract by the former to furnish the latter with a guaranteed amount of traffic cannot be fulfilled without a loss to the Lake Shore.

New Railroads.—Engineers are said to be in the field, running a line south from La Moure, Dak. They are supposed to be continuing the location of the line, of the James River Valley road, recently purchased by Messrs. Livingston and Merriam of St. Paul.

Penna. R. R.—It is thought to be the intention of the Pennsylvania Railroad Company to push its Schuylkill Valley branch beyond Pottsville and into the Hazleton and Wyoming Valley coal regions, thus affording another direct communication between that wealthy region and Philadelphia.

Railroad Rumors.—Rumors are current that the Milwaukee & St. Paul has purchased the Winona, Alma & Northern, and would permanently abandon all work upon the new line. The Winona, Alma & Northern skirts the east shore of the Mississippi. The Milwaukee and St. Paul's River division runs along the West Shore.

The Galesburg, Lacon and Chicago Company has been organized to build a road from Galesburg to Lacon, where a connection will be made with the Chicago and Alton and Rock Island.

The Kansas City and Southern R. R. Co. is laying one mile of track per day north from Clinton, Mo., and it is intended to put force enough on to string out three miles per day. The road is completed about 20 miles south from Clinton, and has depots built and trains making regular runs with a good freight and passenger business.

Wilmington, N. C. & Welden R. R.—President Bridgers, of the Wilmington and Welden Railroad Company, has advertised for proposals to build a branch railroad from a point near Wilson to Fayetteville, a distance of seventy miles. This is a part of the projected line which will shorten the time on the Atlantic Coast line two and a half hours.

Hopkinsville and Cadiz Railroad.—To extend from Hopkinsville, Ky., to Cadiz, and thence to some point on the Chesapeake and Ohio, yet to be determined. H. G. Abernathy, W. G. Wheeler, S. G. Buckner, J. I. Landes, W. J. Withers and Lucian Jones, of Hopkinsville, and M. H. Grinter, Dr. J. W. Crenshaw and Thos. C. Dabney, of Cadiz, Directors.

Nevada and Minden Railway.—The survey has been completed. The proposed route touches the southeast corner of Moundville, Vernon County, and cross the Gulf Road a few hundred yards east of Liberal, Barton County, thence south to Minden. It passes through a rich farming country and perhaps the finest coal fields in Southwest Missouri. Work will begin on the road in about four weeks.

Surveying the Route.—St. Joseph, Mo., March 24.—A full corps of surveyors, under Major Hinike, began at Hanover this morning the preliminary survey of the proposed St. Joseph, Hanover and Southwestern Railway. The people are enthusiastic and are prepared to push the road to completion. This line is designed as a feeder to the St. Joseph and Western Railroad and will extend from Hanover to Clay Center, Kan.

New Railroads.—A survey has just been completed for a railroad from St. Joseph, Mo., to Lake Contrary, five miles south, by the Kansas City, St. Joseph and Council Bluffs Railroad Company. The people living near the lake have been trying for years to induce the Kansas City to build the road, offering the right of way and depot grounds as an inducement, but no heed was paid to the request until a scheme was started to build a narrow gauge which should touch the lake.

Marshall, Texas, Northwestern R. R.—The first five miles of iron have been received. Vice-President Hearbsill of Marshall says the road will be pushed at once. The necessary amount of money is already raised and the backers of the project are several California capitalists. The road will be built from Marshall to Paris, Texas, in a northwesterly direction, and southwest from Marshall to Lake Charles, La. This will open up the largest and finest section of pineries in the Southwest.

Troy and Boston R. R.—Chief Engineer Finch, of the Troy and Boston Railroad, and a surveying party, have been engaged for several days making a survey west from Green Island. This proceeding has given rise to a report that a branch was to be built from Troy to Schenectady, to connect the West Shore with the Troy and Boston, and thus give the former an outlet to Boston. President Robinson, of the Troy and Boston, says his company does not contemplate such a construction. It is thought the West Shore people may build the road.

A New Railroad.—Articles of incorporation of the Ortonville & Lake Superior Railroad company were filed with the secretary of state Saturday, for constructing a double track railway from Ortonville, Big Stone country, northeasterly to a point to be determined on Lake Superior, with extensions and branches. The business of the company is to be transacted at Ortonville, Minn. The corporation is to date from March 12, 1885, and continue for a period of fifty years. The first board of directors are Cornelius K. Orton, Charles E. Brooks, Leslie C. Lane, Thomas M. Grant and Bernard Dassel, of Ortonville, who are also the incorporators.

Mobile and West Alabama R. R.—MOBILE, ALA., March 27.—After a day devoted to discussion, the incorporators of the Mobile and West Alabama Railroad organized this morning by electing T. P. Miller, John T. Milner, T. G. Bush, D. T. Parker, G. B. Clark, Thomas Henry, and P. D. Barker, Directors. T. G. Bush was elected President, John T. Milner Vice-President, and G. E. Miller Secretary and Treasurer. The basis of the new road is the old Alabama Grand Trunk, whose securities will be exchanged for those of the new organization. The road is projected from Mobile to the Walker County coal fields, and eventually to the Tennessee River, 96 miles of which are already constructed. The men at the head of this enterprise have the hearty co-operation of the people all along the line, and the road will be built without delay.

New Bridges.—President Ingalls, of the C., I., St. L. & C., has given orders to replace the wooden bridges over Crooked creek, on the western division, with an iron and steel bridge, and on the eastern division a similar improvement is to be made over Sand creek, Laughery creek and Lewis creek. All are one span bridges.

Senate bill by Mr. McLyman—Authorizing Toledo to issue bonds and borrow $.50,000 for bridge purposes, has passed the Ohio Legislature.

Chattanooga is anxious to build a free bridge across the Tennessee River, or rather the county, at an expense of some $185,000, and a bill has passed the Senate facilitating such action.

The Canadian Pacific's Ultimatum.—MONTREAL, March 27.—It is said the Canadian Pacific Railway Co. has sent an ultimatum to the Government of Ottawa to the effect that if aid is not given further construction of the road will be suspended. Seven millions of the company's paper is maturing between now and next June, and the company has not money to meet it. Financiers here say that if this paper is allowed to go to protest the result will be disastrous to the trade of the country. *La Minerva*, a Government paper, says to-day that if the Government does not come to the company's aid the result will be little short of a national disaster. The Government fears to advance anything more for fear of a defeat in the House.

The Duluth & Winnipeg.—DULUTH, March 27.—The meeting of the chamber of commerce to discuss the question of a railroad to Grand Forks was largely attended, and was more like a mass meeting of citizens. Judge Cox of Grand Forks outlined a plan of action which was favored by the people of that place. After an interesting discussion of the question a committee was appointed to take the whole question of building the road into consideration, and it will be decided whether it will be best to work for the old Duluth & Winnipeg road or to organize a new company and make a fresh start.

LIKELY TO BE BUILT.

DULUTH, Special Telegram, March 27.—To-day Senator Billson received the following telegram from Oliver W. Barnes, 57 Broadway, New York:

"I have undertaken to construct the Duluth & Winnipeg railroad on condition that the counties along the line contribute satisfactory bonuses in its aid. We expect Duluth and St. Louis county to give us $.00,000. Prompt action on the part of your citizens will secure the early commencement of the work."

Mr. Barnes is not known to our people, but is said to be a well-known railroad engineer, associated with the Vanderbilt roads, and a man who has been instrumental in building several important roads, and has confidence in the money market. Negotiations have been conducted with him by Boston parties, who have had control of the Duluth & Winnipeg charter and franchise for a year or more. These negotiations stopped last fall about election time, but have recently been reopened. Ex-Senator James Hill went to New York on Duluth & Winnipeg business a few days ago, and it is supposed a meeting of Duluth & Winnipeg stockholders was held there, with the results as told in the above telegram.—St. Paul *Pioneer Press*, 3-28.

St. Paul, Brainerd and Northwestern.—BRAINERD, March 27.—The first stake on the St. Paul, Brainerd and Northwestern, Northern division, was driven today, the engineering party having started the work o location this afternoon. The party is thus organized:

Chief, G. S. Canfield; quartermaster, O. H. Havill; commissary, F. B. Thompson; chief woodsman, W. E. Seelye; engineer-in-chief, A. H. Case of Fountain, Minn. assistant, J. L. Anderson.

The party comprises twenty seven persons in all and goes out equipped for sixty days, in which time they expect to reach Red Lake Falls. The four first mentioned are incorporators, stockholders and directors of the company, who thus propose to know practically all about the enterprise they have on foot. The canvas for the vote of $50,000 in bonds by this city, for a dam over the mississippi here, is progressing favorably. The vote occurs on the 7th of April.

Macon and Dublin Railroad.—The meeting in the interest of the above named road, which was held in Jeffersonville on the 12th of March, was, we are informed, attended by many of the best and most substantial citizens of Twiggs, Laurens and Wilkinson counties. Mr. J. F. Burke, of this county, and Mr. Iverson L. Hunter, of Twiggs, were selected chairman and secretary respectively.

Able addresses, containing much practical knowledge about railroads and the building thereof, were made by Hons. M. Hughes and Hubbard Reynolds, of Twiggs, and by Colonel John M. Stubbs, of Laurens, and Civil Engineer Arthur Pou, of Talbotton. The articles of association were then signed and much stock in the enterprise subscribed for. The result was so satisfactory in all respects, a corps of engineers were immediately employed and will proceed to locate the road, commencing on the Dublin end on the 1st of April.

A competent committee was appointed to push forward subscriptions to the capital stock of the road and report to a meeting to be held at Allentown on the 1st day of April.

All citizens who are interested in the matter are invited to meet at Allentown on the day named.—Irwington, *Appeal*, Georgia.

Omaha & Chicago and St. Paul.—The Omaha people have completed a survey for an extension of their road from River Falls southeast to Ellsworth, a distance of 12 miles. According to the charter originally granted by the Wisconsin legislature, the Omaha company was to have constructed a line from Lake Superior to the Mississippi. This line was built as far as River Falls, but was never continued beyond that point. The present legislature changed the provisions of the charter, and the Omaha is no longer compelled to build to the Mississippi, but instead will build to Ellsworth. The report that this line will be continued to Red Wing is without foundation.—St. Paul *Pioneer Press.*

Index to Periodical Literature.

Architectural Design. *Principles of Architectural Design.* A consise statement of some of the principles and characteristics of architectural design: refinement in design, concentration of ornament, true use of detail balance in design, economy of material, contrast avoidance of extravagance of manner, suitability, harmony, color, work founded on that of the past consonance with nature, truth. From a lecture delivered at the Royal Academy, by C. F. Bodley. *The Architect*, March 7, 1885, pp. 144 to 146.

Beams, Steel, *see* **Strength of Materials, Steel.**

Breakwaters, Floating. *Floating Breakwaters.* A brief description of a form of floating breakwater for harbors of refuge, lately brought out in England Consists of line of floating fence, of timber or tubular metal, suitably anchored, and effectively breaking up the waves. *Iron Age*, March 19, 1885, p. 15.

Bridge, Chestnut St. *Repairs to Philadelphia Chestnut St. Bridge.* A history of the defects and the remedies applied. Description of the repairs by pneumatic tubes, a theory of the cause of the cracks, and an opinion that this method of repairing will be inefficient. Very fully illustrated. By C. Elder Lindsey. *R. R. Gazette*, Jan. 20, 1885, pp. 68 and 69.

Cable Railway.—*The trouble with the Philadelphia Traction Company's Road.* Columbia Ave. branch of the cable road was stopped by the closing of the slob by frost. Defect in the original conduit and in the proposed remedy. Advantages of substituting a cast iron conduit. Illustrated by W. Barnet Le Van. *American Machinist*, March 28, 1885, p. 4.

Car Ferry.—*Landing Arrangements for a Car Ferry on the Mississippi River.* The works described are situated opposite St. Louis. The method of overcoming the difficulty in construction and maintenance, due to 31 feet range of water, swift currents, changeable store line, floods etc., are fully described, and the works illustrated in detail. A valuable article on a subject on which very little has been written. By Robt. Moore. *Trans. Am. Soc. Civil Engineers.* Aug. 1884, pp. 247 to 252.

Culverts.—A full consideration of certain rules to be followed in the designing of culverts, with several illustrations. *R. R. Gazette*, Jan. 23, 1885, pp. 54 and 55.

Docks.—*The Ore Docks at Ashland, Wis.* These docks now under construction for the M., L. S. & W. R. R. are to be, it is said, the largest of the kind in the world. The description is illustrated with several views. *Iron Trade Review*, March 14, 1885, pp. 163 and 165.

Ferry, Car *see* **Car Ferry.**

Foundations, Pneumatic *see* **Bridge, Chestnut Street.**

Iron Crystallization.—*Elevated Roads.* A valuable and interesting report on the tests made of iron taken from the structure of the New York Elevated railroads, after a service of six years. The report goes elaborately into the subject of crystallization by repeated shocks, states that there were no signs of crystallization in any of the piers tested, that crystallization will never take place in good iron loaded within certain limits, and that repeated stresses within their limits tend to improve the iron. By Robt. H. Thurston, New York *Mail* and *Express*, March 21, 1885.

Joints and Joint Making.—A paper treating of joints in pipe under pressure of water and other fluids, under the following headings. Spigot and socket joints; flayed joints; screwed joints, and solder joints. Fully illustrated. Read by T. Duncauson. *Proc. Liverpool Engineering Society*, 1883, pp. 103 to 115.

Lighthouse Specifications.—*Specification for Light-Apparatus of the Second Order for Watling Island Lighthouse, and Specifications for Iron Fittings, etc., for ditto.* These are given in full, the drawings being omitted, and are for English Lighthouses. *Contract Journal.* Jan. 28, 1885, pp. 110, 111.

Sewerage—New Orleans.—*The New Orleans Auxiliary Sanitary Association and the Flushing System.* A brief account of the method employed by the Association for cleaning the street gutters and drainage canals of the sewage emptied into them from the house drains, by means of flushing. Illustrated. *Sanitary Engineer.* March 19, 1885, p. 329.

Strength of Materials, Steel.—*The Strength and Elasticity of Structural steel, and its Efficiency in the Form of Beams and struts.* Results of experiments made at the Pencoyd Iron Works with "mild" and "hard" Bessemer Steel, given both in tabular and graphical form, and discussed. The elasticity of steel is also considered. By Jas. Christie. *Trans. Am. Soc. of Civil Engineers.* August 1884, pp. 253 to 266; with discussion, *Trans etc.*, September 1884, pp. 267 to 294.

Strength of Materials.—Struts.—*Experiments on the Strength of Wrought Iron Struts.* Made at the Pencoyd Iron-works to determine the comparative resistance to compression of long and short struts of rolled angle, tie, beam and channel sections, with flat ends, fixed ends, hinged ends and round ends. The results are shown in tables and by diagrams. By Jas. Christie. *Trans Am. Soc. of Civil Engineers.* April 1884, pp. 85 to 122; with discussion, *trans etc.*, Sept. 1884, pp. 267 to 294.

Struts, Steel. *See* **Strength of Materials, Steel.**

Struts, Wrought Iron. *See* **Strength of Materials, Struts.**

Sewer Ventilation. The detection of gases in sewers, and the various methods of preventing their accumulation. From a paper read by James Kelsall *Sanitary World*, Jan. 31, 1885, pp. 133 and 134.

Turbine, Test. *Experiments on the Humphrey Turbine Wheel*, at the Tremont and Suffolk Mills, in Lowell, Mass. The wheel (275 H. P., under 13 feet head), has an inward flow with a downward and outward discharge. The results are given in tabular and graphical form, and the machine is described, and illustrated in plan and section on a large scale. By Jas. B. Francis. *Trans. Am. Soc. Civil Engineers*, Sept., 1884, pp. 295 to 302.

Water, Flow of.—*Description of some Experiments on the Flow of Water through 2¼ inch Rubber Hose, and Nozzles of Various Forms and Sizes, made on the Providence, R. I., Water Works. Also results of Investigations relating to the Heights of Jets of Water.* Illustrated with many diagrams and tables. By Edmund B. Weston. *Trans. Am. Soc. Civil Engineers*, Nov. 1884, pp. 376 to 395.

Water Supply-Regulations. *The Regulation of the Supply of Water to Cities and Towns.*—Necessity of some instruments to control the supply. Description of an apparatus for regulating the pressure in the mains. Paper read before the Glasgow Philadelphia Soc. by Wm. Key. *Sanitary World*, Jan. 31, 1885, pp 140 and 141, *et seq.*

Wood-Working Machinery.—*On Recent Improvements in Wood-Cutting Machinery.* Planing, dimensions, sawing, band-sawing, panel-planing machinery etc., described and illustrated. By George Richards. *Trans. Inst. Mech. Engineers* (England Also in *Engineering*, Feb. 13, 1885, pp. 164 to 164.

Market Report of Engineering Materials.

New York, April 2, 1885.

NOTE.—The following Market Report gives wholesale prices on the New York Market unless otherwise stated. It is intended as a general guide to the estimating engineer, and both the range of material and the market location will be extended as rapidly as possible. We give it with this caution, that, as is well understood in business transactions, the amount of bill, distance from market centre and conditions of payment will have a material influence on the final paying prices.

IRON.

STRUCTURAL IRON.			
Angles		2.2c.	@ 2.6c.
Tee		2.8c.	@ 3c.
Beams and channels		3.0c.	@ 3.5c.
Tank		2.1c.	@ 2.15c.
Shell		2¼c.	
Steel plates, Tank		3c.	@ 3½c.
WROUGHT-IRON PIPE., PITTSBURGH.			
Butt welded, black	Discount	50	
" " galvanized	"	40	
Lap welded black	"	50	
" Galvanized	"	67½	
Boiler tubes	"	60	
RAILS.			
Steel (large lots at mill)		$26	@ 26.50
Old rails		17.	@ 17.50
Old rails, steel		16	@ 17
R. R. spikes			
R. R. splice-plates		1.65c.	@ 1.75c.
R. R. Track Bolts		2.35c.	@ 2.65c.
Barb-wire fencing, galvanized		4¾c.	@ 5¼c.
" " painted		3¾c.	@ 4¼c.
Corrugated iron			
Nails			
Iron		2.25	
Steel		2.35	

METALS.

COPPER.		
Lake Superior	11	@ .11¼
Other Brands	10¾	@ 10¾
LEAD.		
Com. Domestic	3.60	@ 3.70
Lead Pipe	.06¾	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.06¾	
ZINC.		
Sheet	5.15	@ 5.25

BRICK.

(Cargoes afloat)		
Haverstraw 1st per M.	$6.00	@ 6.25
" 2nd "	5.62	@ 5.87
Fishkill	4.75	@ 5.50
Up-River		
Jerseys	5.25	@
Long Island		
" pale		
FRONTS.		
Croton red	14.00	@
" dark	14.00	@
" brown	12.00	@
Philadelphia pressed	22.50	@ 23.00
Trenton "	22.50	@ 23.00
Baltimore "	37.00	@ 41.00
Buff "	33.00	@ 35.00
Enameled English	65.00	@ 130.00
" American	85.00	@ 120.00
Fire brick	25.00	@ 40.00

CEMENT.

PORTLAND.			
Robins & Co., Extra English	425 lbs. per bbl.	2.75	@ 2.90
K. B. & S. English	400 lbs.	2.85	@ 3.00
Burham "	" "	2.70	@ 2.85
Rochester Castle "	" "	2.50	@ 2.60
J. B. White & Bro. "	" "	2.50	@ 2.60
Other brands, "	" "	2.40	@ 2.50
Keene's fine "	" "	9.50	@ 9.75
" course "	" "	5.25	@ 5.50
Roman		2.75	@ 3.50
Dyckerhoff, German	400 lbs.	2.60	@ 2.65
Star, "	" "	2.60	@ 2.65
Alsen, "	" "	2.55	@ 2.60
Hanover "	" "	2.40	@ 2.50
Other brands, "	" "	2.35	@ 2.40
Saylor's American		2.15	@ 2.50
F. O. Norton		1.10	
Rosendale cements		0.90	@ 1.10

LIME.

Rockland common per bbl.	1.00	
" finishing	1.20	
Glensfalls, common	.85	
" finishing	1.05	@ 1.10
Kingston, ground	0.95	

STONE.

Cargo rates at New York.

Amherst freestone, No. 1	per cub. ft.	0.90	@ 95
" " No. 2	"	0.75	@ 0.80
" " light drab	"	0.80	@ 0.95
Berlin " in rough	"	0.75	@ 1.00
Berea "	"	0.75	@ 1.00
Brownstone, Portland, Ct.	"	1.00	@ 1.30
" Belleville, N. J.	"	0.75	@ 1.25
Granite, rough	"	0.60	@ 1.25
Common building stone per load		2.00	@ 3.00
Base stone, from 2½ to 6 ft. lengths, per lin. ft.		0.40	@ 3.00

SLATE.

Purple roofing	per square	6.00	@ 7.00
Green	"	6.00	@ 7.00
Red	"	15.00	
Black Penna. (at New York)	"	4.50	@ 5.00

LUMBER.

PINE, Common box	per M.	18.00	@ 20.00
Good	"		
Tally plank, 1¼ in	each.	.44	@ .50
Tally boards, dressed	"	.28	@ .30
SPRUCE, Boards dressed	"	.25	@ .28
Plank, 1¼ in	"	.28	@ .30
" 2 in.	"	.38	@ .40
" 2 in. dressed	"	.43	@ .45
Timber	per M.	20.00	@ 22.00
HEMLOCK, Boards	each.	.18	@ .20
Joist, 2½ × 4 to 4 × 6 in	"	.17	@ .44
OAK	per M.	55.00	@ 65.00
CYPRESS 1, 1¼, 2 and 2½ in	"	35.00	@ 40.00
YELLOW PINE, Girders	"	26.00	@ 35.00
Dressed flooring	"	30.00	@ 40.00
SHINGLES, Extra shaved pine, 18in.	"		
" sawed 16 in.	"	4.50	@ 5.00
LATH, Cargo rate	"	2.50	@ 2.60

PAINT.

Lead, white, American dry	per lb	.04¾ @ .05
" " in oil pure	"	.05½ @ .05¾
English, B. B. in oil	"	.08¼ @ .08¾
Red, American	"	.05½ @ .05½
Litharge	"	.05 @ .05¼
Venetian red, American	"	.01 @ .01½
Indian red	"	.05 @ .10
Vermillion, American lead	"	.11 @ .11½
Paris green	"	.15 @ .19
Umber, Amer. raw and powdered	per lb.	.01¼ @ .01½
Drop black, Amer.	"	.08 @ .12
" " "	"	.09 @ .11½
Chrome green	"	.05 @ .15
Oxide zinc, American	"	.03¼ @ .04
" French	"	.06¼ @ .06¾

THE use of carbonized cement pipe will be permitted for house construction in Lynn, Mass., if manufactured in that city.

A NEW WATER COMPANY has been formed at Birmingham, Ala., and proceedings to condemn lands for its uses are under way.